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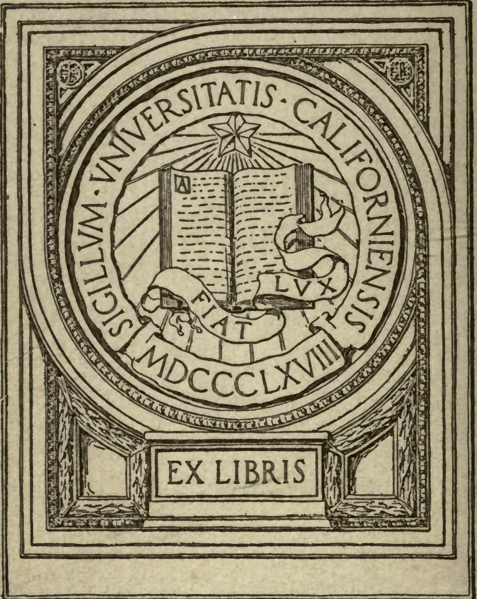
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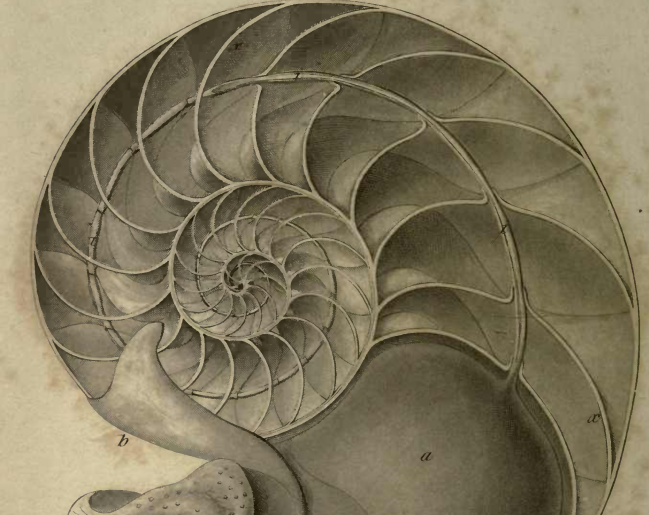
THE PEARLY NAUTILUS

(after Owen)



a — The mantle
b — Its dorsal fold
e — Nidamental Gland
g — Shell muscle
i i i Siphon
k — Funnel

n — Hood
o o o Exterior digitations
p — Tentacles
s — Eye
x x Septa
z — Last Chamber

J.W. Lowry

London, John Weale, 59, High Holborn, 1851.

A

MANUAL OF THE MOLLUSCA;

OR, A

RUDIMENTARY TREATISE

OF

RECENT AND FOSSIL SHELLS.

BY

green

S. P. WOODWARD,

ASSOCIATE OF THE LINNEAN SOCIETY;
ASSISTANT IN THE DEPARTMENT OF MINERALOGY AND GEOLOGY
IN THE BRITISH MUSEUM; AND
MEMBER OF THE COTTESWOLDE NATURALISTS' CLUB.

ILLUSTRATED BY

A. N. WATERHOUSE AND JOSEPH WILSON LOWRY.

LONDON:
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CONTENTS.

PAGE

Table of the Sub-kingdoms and Classes of Animals 2

INTRODUCTION.

CHAPTER I.

On the Position of the Mollusca in the Animal Kingdom. —Characters of the four primary groups;—Vertebrata—Mollusca—Articulata—Radiata. Their equal antiquity ... 3

CHAPTER II.

Classes of the Mollusca.—1. Cephalopoda.—2. Gasteropoda. — 3. Pteropoda. — 4. Brachiopoda. — 5. Conchifera. — 6. Tunicata 6

CHAPTER III.

Habits and Economy of the Mollusca.—Sedentary tribes, their mode of attachment; locomotive tribes, their means of progression; situations frequented by shell-fish.—Food: vegetable- infusorial- and animal-feeders.—Use of shell-fish to other animals for food; use of shells for ornamental and other purposes; prices of shells.—Duration of molluscous animals; tenacity of life; fecundity; oviposition 10

252012

CHAPTER IV.

PAGE

STRUCTURE AND PHYSIOLOGY OF THE MOLLUSCA. — Nervous system; organs of sense.—Muscular system.—Digestive system; lingual teeth; secretions.— Circulating system; aquiferous canals. — Respiratory system. — The shell, its composition and structure; nacreous, fibrous, and porcellaneous shells; epidermis; erosion of fresh-water shells. Formation and growth of the shell; adult characters; decollated shells; monstrosities; colours; the operculum; homologies.— Temperature and hybernation. — Reproduction: of lost parts; by gemmation; viviparous; alternate; oviparous.—Development 21

CHAPTER V.

CLASSIFICATION.—Affinities; analogies; species; genera; families; the quinary system 55

CHAPTER VI.

NOMENCLATURE.—Synonyms; authorities; types 59

ABBREVIATIONS 61

SYNOPSIS OF THE GENERA.

CLASS I. CEPHALOPODA. ORDER I. DIBRANCHIATA 62

SECTION A. OCTOPODA 64

Fam. I. Argonautidæ.—Argonauta 66

Fam. II. Octopodidæ.—Octopus, Pinnoctopus, Eledone, Cirroteuthis, Philonexis 67

SECTION B. DECAPODA 68

Fam. III. Teuthidæ.—Loligo, Gonatus, Sepioteuthis, Beloteuthis, Geoteuthis, Leptoteuthis, Cranchia, Sepiola, Loligopsis, Cheiroteuthis, Onychoteuthis, Enoploteuthis, Ommastrephes 69

PAGE

Fam. IV. Belemnitidæ.—Belemnites, Belemnitella, Acanthoteuthis, Belemnites, Belemnoteuthis, Conoteuthis ... 73

Fam. V. Sepiadæ.—Sepia, Spirulirostra, Beloptera, Belemnosis 76

Fam. VI. Spirulidæ.—Spirula 77

ORDER II. TETRABRANCHIATA........ 83

Fam. I. Nautilidæ.—Nautilus, Lituites, Trochoceras, Clymenia........ 83

Fam. II. Orthoceratidæ.—Orthoceras, Gomphoceras, Oncoceras, Phragmoceras, Cyrtoceras, Gyroceras, Ascoceras 87

Fam. III. Ammonitidæ.—Goniatites, Bactrites, Ceratites, Ammonites, Crioceras, Turrilites, Hamites, Ptychoceras, Baculites 91

CLASS II. GASTEROPODA 97

ORDER I. PROSOBRANCHIATA 103

SECTION A. SIPHONOSTOMATA 104

Fam. I. Strombidæ.—Strombus, Pteroceras, Rostellaria, Seraphs........ 104

Fam. II. Muricidæ.—Murex, Pisania, Ranella, Triton, Fasciolaria, Turbinella, Cancellaria, Trichotropis, Pyrula, Fusus........ 106

Fam. III. Buccinidæ.—Buccinum, Pseudoliva, Anolax, Halia, Terebra, Eburna, Nassa, Phos, Ringicula ?, Purpura, Purpurina, Monoceros, Pedicularia, Ricinula, Planaxis, Magilus, Cassis, Oniscia, Cithara, Cassidaria, Dolium, Harpa, Columbella, Oliva, Ancillaria........ 110

Fam. IV. Conidæ.—Conus, Pleurotoma 117

Fam. V. Volutidæ.—Voluta, Cymba, Mitra, Volvaria, Marginella 118

Fam. VI. Cypræidæ.—Cypræa, Erato, Ovulum........ 120

PAGE
SECTION B. HOLOSTOMATA 122
Fam. I. *Naticidæ.*—Natica, Sigaretus, Lamellaria, Narica, Velutina 122
Fam. II. *Pyramidellidæ.*—Pyramidella, Odostomia, Chemnitzia, Stylina, Loxonema, Macrocheilus... Eulima 125
Fam. III. *Cerithiadæ.*—Cerithium, Potamides, Nerinæa, Fastigiella, Aporrhais, Struthiolaria 127
Fam. IV. *Melaniadæ.*—Melania, Paludomus, Melanopsis... 130
Fam. V. *Turritellidæ.*—Turritella, Aclis, Cæcum, Vermetus, Siliquaria, Scalaria 132
Fam. VI. *Litorinidæ.*—Litorina, Solarium, Phorus, Lacuna, Litiopa, Rissoa, Skenea, Truncatella, ? Lithoglyphus ... 134
Fam. VII. *Paludinidæ.*—Paludina, Ampullaria, Amphibola, Valvata 138
Fam. VIII. *Neritidæ.*—Nerita, Pileolus, Neritina, Navicella 140
Fam. IX. *Turbinidæ.*—Turbo, Phasianella, Imperator, Trochus, Rotella, Monodonta, Delphinula, Adeorbis, Euomphalus, Stomatella, Broderipia 142
Fam. X. *Haliotis.*—Haliotis, Stomatia, Scissurella, Pleurotomaria, Murchisonia, Trochotoma, Cirrus, Ianthina 146
Fam. XI. *Fissurellidæ.*—Fissurella, Puncturella, Rimula, Emarginula, Parmophorus. 149
Fam. XII. *Calyptræidæ.*—Calyptræa, Crepidula, Pileopsis, Hipponyx 151
Fam. XIII. *Patellidæ.*—Patella, Acmæa, Gadinia, Siphonaria 153
Fam. XIV. *Dentaliadæ.*—Dentalium 156
Fam. XV. *Chitonidæ.*—Chiton 156

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NOTICE.

THE second part of this Manual is now in preparation, and will be published early in the summer. It will contain an account of the remaining orders of shell-fish: a chapter on the Geographical Distribution of the Mollusca, with a Map of the Marine and Terrestrial Provinces; a chapter on the distribution of Fossil Shells; another on the methods of collecting and preserving Land, Fresh-water, and Sea-shells; the Preface; and an Index of the genera and technical terms.

The writer desires to acknowledge his obligations to Mr. Hugh Cumming, Professor Edward Forbes, and other gentlemen who have assisted him by advice, and the loan of specimens; also to Mr. Van Voorst, for permission to copy some interesting igures from the "British Mollusca;" and his thanks are most especially due to Mr. John Edward Gray, Keeper of the Zoological Department of the British Museum, for access to his library and cabinet, and the use of some of the best engravings which llustrate these pages.

Kingdom ANIMALIA.

Sub-kingdom I. VERTEBRATA.

Class I. Mammalia.
II. Aves.
III. Reptilia.
IV. Pisces.

Sub-kingdom II.
MOLLUSCA.

Class I. Cephalopoda.
II. Gasteropoda.
III. Pteropoda.
IV. Brachiopoda.
V. Conchifera.
VI. Tunicata.

Sub-kingdom III.
ARTICULATA.

Class I. Insecta.
II. Arachnida.
III. Crustacea.
IV. Cirripeda.
V. Anellata.
VI. Entozoa.

Sub-kingdom IV. RADIATA.

Class I. Acalepha.
II. Echinodermata.
III. Zoophyta.
IV. Foraminifera.
V. Infusoria.
VI. Amorphozoa.

A
MANUAL OF THE MOLLUSCA.

INTRODUCTION.

Chapter I.

ON THE POSITION OF THE MOLLUSCA IN THE ANIMAL KINGDOM.

All known animals are constructed upon four different types, and constitute as many natural divisions or sub-kingdoms.

1. The first of these primary groups is characterized by an internal skeleton, of which the essential, or ever-present part, is a backbone, composed of numerous joints, or *vertebræ*. These are the animals most familiar to us; beasts, birds, reptiles, and fishes, are four classes which agree in this one respect, and are hence collectively termed vertebrate animals, or the *vertebrata*.

2. Another type is exemplified in the common garden-snail, the nautilus, and the oyster; animals whose soft bodies are protected by an external shell, which is harder than bone, and equally unlike the skeleton of fishes, and the hard covering of the crab and lobster. These creatures form the subject of the present history, and are called *mollusca*.*

---

* *Mollusca* soft (animals), from *mollis*. The Greeks termed them *Malakia*, whence the modern word *Malacology*, or the study of shell-fish.

3. The various tribes of insects, spiders, crabs, and worms, have no internal skeleton; but to compensate for it, their outer integument is sufficiently hard to serve at once the purposes of bones, and of a covering and defence. This external armature, like the bodies and limbs which it covers, is divided into segments or joints, which well distinguishes the members of this group from the others. The propriety of arranging worms with insects will be seen, if it be remembered, that even the butterfly and bee commence existence in a very worm-like form. This division of jointed animals bears the name of the *articulata.*

4. The fourth part of the animal kingdom consists of the coral-animals, star-fishes, sea-jellies, and those countless microscopic beings which swarm in all waters. Whilst other animals are bi-lateral, or have a right and left side, and organs arranged in pairs,—these have their organs placed in a circle around the mouth or axis of the body, and have hence obtained the appellation of *radiata.*

These groups illustrate successively the grand problems of animal economy. The lower divisions exhibit the perfectionizing of the functions of nutrition and reproduction; the higher groups present the most varied and complete development of the senses, locomotive powers, and instincts. We may also trace in them an ideal progression from the simplest to the most complicated structure and conditions. Commencing with the Infusorial monad, we may ascend in imagination by a succession of closely allied forms, to the sea-urchin and holothuria*; and thence by the lowest organized worms, upwards to the flying insect. Or, starting at the same point, we may pass from the polypes to the tunicaries; and from the higher kinds of shell-fish to the true fishes, and so on to those classes whose physical organization is most nearly identical with our own.

The *mollusca* are thus related to two of the other primary groups;—by the affinity of their simpler forms to the *zoophytes,* and of their highest class to the fishes;—to the cirripedes and other articulate animals, they present only superficial and illusive resemblance.

---

* See the History of British Star-fishes, by Professor E. Forbes.

And further, we shall find that although it is customary to speak of shell-fish as "less perfect" animals, yet they really attain the perfection of their own type of structure; indeed it would seem to have been impossible to make any further advance, physical, or psychical, except by adopting a widely different *plan* from that on which the molluscous animals have been constructed.

The evidence afforded by geological researches at present tends to shew that the four leading types of animal structure have existed simultaneously from the very beginning of life upon the globe;* and though perpetually varying in the form under which they were manifested, they have never since entirely ceased to exist.

By adding to the living population of the world, those forms which peopled it in times long past, we may arrive at some dim conception of the great scheme of the animal kingdom. And if at present we see not the limits of the temple of nature, nor fully comprehend its design,—at least we can feel sure that there is a boundary to this present order of things; and that there has been a plan, such as we, from our mental constitution, are able to appreciate, and to study with ever-increasing admiration.

---

* Mr E. Logan, Geological Surveyor of the Canadas, has discovered *foot prints of a tortoise*, near Montreal, in the "Lingula Shale," or oldest fossibiferous rock at present known.

CHAPTER II.

CLASSES OF THE MOLLUSCA.

THE *mollusca* are animals with soft bodies, enveloped in a muscular skin, and usually protected by a univalve or bivalve shell. That part of their integument which contains the viscera and secretes the shell, is termed the *mantle;* in the univalves it takes the form of a sac, with an opening in front, from which the head and locomotive organs project: in the bivalves it is divided into two lobes.

The univalve mollusca are *encephalous*, or furnished with a distinct head; they have eyes and tentacula, and the mouth is armed with jaws. Cuvier has divided them into three classes, founded on the modifications of their feet, or principal locomotive organs.

1. The cuttle-fishes constitute the first-class, and are termed *cephalopoda*,* because their feet, or more properly *arms*, are attached to the head, forming a circle round the mouth.

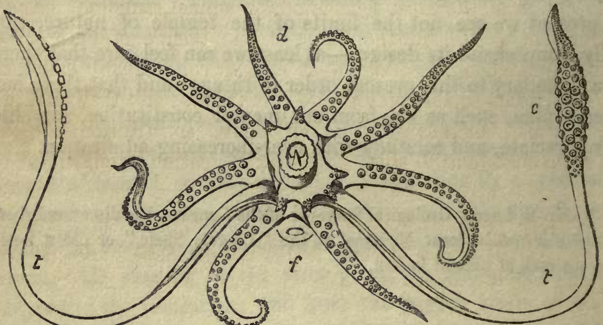

Fig. 1.† *Oral aspect of a Cephalopod.*

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* From *Cephale*, the head and *poda* feet. See the frontispiece and pl. I.

† Fig. 1. *Loligo vulgaris*, Lam. ¼. From a specimen taken off Tenby, by J. S. Bowerbank, Esq. The mandibles are seen in the centre, surrounded by the circular lip, the buccal membrane (with two rows of small cups on its lobes), the eight sessile arms, and the long pedunculated tentacles (t), with their enlarged extremities or clubs (c). The *dorsal* arms are lettered (d), the funnel (f).

2. In the *gasteropoda,** or snails, the under side of the body forms a single muscular foot, on which the animals creep or glide.

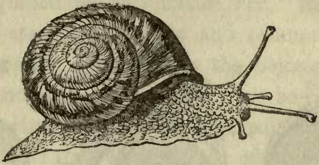

Fig. 2. *A Gasteropod.*†

3. The *pterpoda*‡ only inhabit the sea, and swim with a pair of fins, extending outwards from the sides of the head.

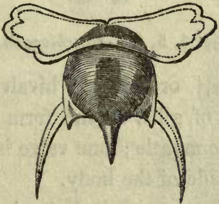

Fig. 3. *A Pteropod.* §

The other mollusca are *acephalous,* or destitute of any distinct head; they are all aquatic, and most of them are attached, or have no means of moving from place to place. They are divided into three classes, characterized by modifications in their breathing-organ and shell.

4. The *brachiapoda*¶ are bivalves, having one shell placed on the back of the animal, and the other in front; they have nc

---

* *Gaster,* the under side of the body.

† Fig. 2. *Helix desertorum.* Forskal. From a living specimen in the British Museum, March, 1850.

‡ *Pteron,* a wing.

§ Fig. 3. *Hyalœa tridentata,* Lam., from Quoy and Gaimard.

¶ *Brachion,* an arm; these organs were supposed to take the place of the feet in the preceding classes.

special breathing organ, but the mantle performs that office ; they take their name from two long ciliated arms, developed from the sides of the mouth, with which they create currents that bring them food.

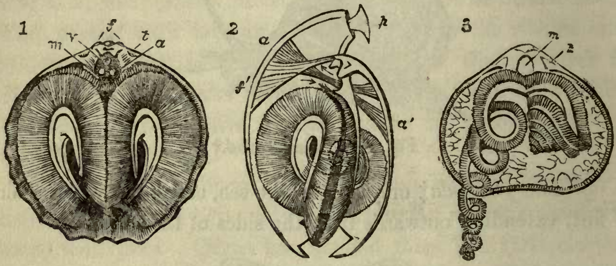

Fig. 4, 5, 6. *Brachiopoda.*[*]

5. The *conchifera,*[†] or ordinary bivalves, (like the oyster), breathe by two pairs of gills, in the form of flat membraneous plates, attached to the mantle ; one valve is applied to the right, the other to the left side of the body.

6. The *tunicata* have no shell, but are protected by an elastic, gelatinous tunic, with two orifices ; the breathing-organ takes the form of an inner *tunic,* or of a riband stretched across the internal cavity.

Five of these modifications of the molluscan type of organization, were known to Linnæus, who referred the animals of all his genera of shell-fish to one or other of them ;[‡] but unfortunately he did not himself adopt the truth which he was the first

[*] Fig. 4. (3). *Rhynchonella psittacea,* Chem, sp., dorsal valve, with the animal (after Owen). 5, 6, *Terebratula australis,* Quoy. From specimens collected by Mr. Jukes. (2). Ideal side view of both valves, (f, the retractor muscles, by which the valves are opened). (1). Dorsal valve. These woodcuts have been kindly lent by Mr. J. E. Gray.

[†] *Conchifera,* Shell-bearers.

[‡] The Linnæan types were—Sepia, Limax, Clio, Anomia, Ascidia. *Terebratula* was included with Anomia, its organization being unknown.

to see; and here, as in his botany, employed an artificial, in preference to a natural method.

The systematic arrangement of natural objects ought not, however, to be guided by convenience, nor "framed merely for the purposes of easy remembrance and communication." The true method must be suggested by the objects themselves, by their qualities and relations;—it may not be easy to learn,—it may require perpetual modification and adjustment,—but inasmuch as it represents the existing state of knowledge it will aid in the UNDERSTANDING of the subject, whereas a "dead and arbitrary arrangement" is a perpetual bar to advancement, "containing in itself no principle of progression." (*Coleridge.*)

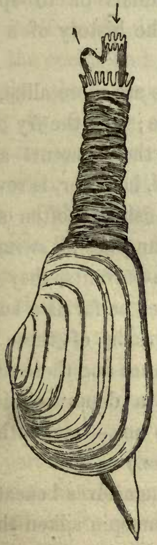

Fig. 7. *A Bivalve.**

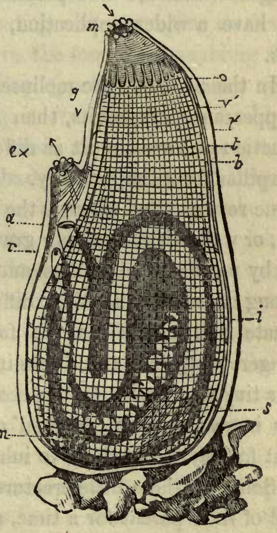

Fig. 8. *A Tunicary.*†

Mya truncata, L. ½. From Forbes and Hanley.

† *Ascidia mentula*, Müll. Ideal representation; from a specimen dredged by Mr. Bowerbank, off Tenby.

CHAPTER III.

HABITS AND ECONOMY OF THE MOLLUSCA.

EVERY living creature has a history of its own; each has characteristics by which it may be known from its relatives; each has its own territory, its appropriate food, and its duties to perform in the economy of nature. Our present purpose, however, is to point out those circumstances and trace the progress of those changes which are not peculiar to individuals or to species, but have a wider application, and form the history of a great class.

In their infancy the molluscous animals are more alike, both in appearance and habits, than in after life; and the fry of the acquatic races are almost as different from their parents as the caterpillar from the butterfly. The analogy, however, is reversed in one respect; for whereas the adult shell-fish are often sedentary, or walk with becoming gravity, the young are all swimmers, and by means of their fins and the ocean-currents, they travel to long distances, and thus diffuse their race as far as a suitable climate and conditions are found. Myriads of these little voyagers drift from the shores into the open sea and there perish; their tiny and fragile shells become part of a deposit that is for ever increasing over the bed of the deep sea,—at depths too great for any living thing to inhabit. (*Forbes.*)

Some of these little creatures shelter themselves beneath the shell of their parent for a time, and many can spin silken threads with which they moor themselves, and avoid being drifted away. They all have a protecting shell, and even the young bivalves have eyes at this period of their lives, to aid them in choosing an appropriate locality.

After a few days, or even less, of this sportive existence, the sedentary tribes settle in the place they intend to occupy during the remainder of their lives. The tunicary cements itself to rock or sea-weed; the shipworm adheres to timber, and the *pholas* and *lithodomus* to limestone rocks, in which they soon excavate a chamber which renders their first means of anchorage unnecessary. The *mya* and razor-fish burrow in sand or mud; the mussel and *pinna* spin a byssus; the oyster and *spondylus* attach themselves by spines or leafy expansions of their shell; the *brachiopoda* are all fixed by similar means, and even some of the gasteropods become voluntary prisoners, as the *hipponyx* and *vermetus*.

Other tribes retain the power of travelling at will, and shift their quarters periodically, or in search of food; the river-mussel drags itself slowly along by protruding and contracting its flexible foot; the cockle and *trigonia* have the foot bent, enabling them to make short leaps; the scallop (*pector opercularis*) swims rapidly by opening and shutting its tinted valves. Nearly all the gasteropods creep like the snail, though some are much more active than others; the pond-snails can glide along the surface of the water, shell-downwards; the nucleobranches and pteropods swim in the open sea. The cuttle-fishes have a strange mode of walking, head-downwards, on their outspread arms; they can also swim with their fins, or with their webbed arms, or by expelling the water forcibly from their branchial chamber; the calamary can even strike the surface of the sea with its tail, and dart into the air like the flying-fish. (*Owen.*)

By these means the mollusca have spread themselves over every part of the habitable globe; every region has its tribe; every situation its appropriate species; the land-snails frequent moist places, or woods, or sunny banks and rocks, climb trees, or burrow in the ground. The air-breathing limneids live in fresh-water, only coming occasionally to the surface; and the auriculas live on the sea-shore, or in salt-marshes. In the sea, each zone of depth has its molluscous fauna. The limpet and periwinkle live between tide-marks, where they are left dry twice a-day; the *trochi* and *purpuræ* are found at low water, amongst the sea-weed; the mussel affects muddy shores, the cockle rejoices in extensive sandy flats. Most of the finely-coloured shells of the tropics are found in shallow water, or amongst the breakers. Oyster-banks are usually in four or five fathom water; scallop-banks at twenty fathoms. Deepest of all, the *terebratulæ* are found, commonly at fifty fathoms, and sometimes at one hundred fathoms, even in Polar seas. The fairy-like *pteropoda*, the oceanic-snail, and multitudes of other floating molluscs, pass their lives on the open sea, for ever out of sight of land; whilst the *litiopa* and *scyllæa* follow the gulf-weed in its voyages, and feed upon the green delusive banks.

The food of the mollusca is either vegetable, infusorial, or animal. All the land-snails are vegetable-feeders, and their depredations are but too well known to the gardener and farmer; many a crop of winter corn and spring tares has been wasted by the ravages of the "small grey slug." They have their likings, too, for particular plants, most of the pea-tribe and cabbage-tribe are favourites, but they hold white mustard in abhorence, and fast or shift their quarters while that crop is on the ground.* Some, like the "cellar-snail," feed on cryptogamic vegetation, or on decaying leaves; and the slugs are attracted by *fungi*, or any odorous substances. The round-mouthed sea-snails are nearly all vegetarians, and consequently limited to the shore and the shallow waters in which sea-weeds grow. Beyond fifteen fathoms, almost the only vegetable production is the nullipore; but here corals and horny zoophytes take the place of *algæ* and afford a more nutritious diet.

The whole of the bivalves, and other head-less shell-fish, live on infusoria, or on microscropic vegetables, brought to them by the current which their ciliary apparatus perpetually excites; such, too, must be the sustenance of the *magilus*, sunk in its coral bed, and of the *calyptræa*, fettered to its birth-place by its calcarious foot.

---

* Dilute lime-water and very weak alkaline solutions are more fatal to snails than even salt.

The carnivorous tribes prey chiefly on other shell-fish, or on zoophytes; since, with the exception of the cuttle-fishes, their organization scarcely adapts them for pursuing and destroying other classes of animals. One remarkable exception is formed by the *stylina,* which lives parasitically on the star-fish and sea-urchin; and another by the testacelle, which preys on the common earth-worm, following it in its burrow, and wearing a buckler, which protects it in the rear.

Most of the siphonated univalves are animal-feeders; the carrion-eating stromb and whelk consume the fishes and other creatures whose remains are always plentiful on rough and rocky coasts. Many wage war on their own relatives, and take them by assault; the bivalve may close, and the operculated nerite retire into his home, but the enemy, with rasp-like tongue, armed with silicious teeth, files a hole through the shell,—vain shield where instinct guides the attack! Of the myriads of small shells which the sea heaps up in every sheltered "ness," a large proportion will be found thus bored by the whelks and purples; and in fossil shell-beds, such as that in the Touraine, nearly half the bivalves and sea-snails are perforated,—the relics of antediluvian banquets.

This is on the shore, or on the bed of the sea; far away from land the *carinaria* and *firola* pursue the floating *acalephe;* and the argonaut, with his relative the *spirula,* both carnivorous, are found in the "high seas," in almost every quarter of the globe. The most active and rapacious of all are the calamaries and cuttles, who vindicate their high position in the naturalists' "system," by preying even on fishes.

As the shell-fish are great eaters, so in their turn they afford food to many other creatures; fulfilling the universal law of eating, and being eaten. Civilized man still swallows the oyster, although snails are no longer reckoned "a dainty dish;" mussels, cockles, and periwinkles are in great esteem with children and the other unsophisticated classes of society; and so are scallops and the *haliotis,* where they can be obtained. Two kinds of whelk are brought to the London market in great quantities; and the arms of the cuttle-fish are eaten by the Neapolitans, and also by the East Indians and Malays. In seasons of scarcity, vast quantities of shell-fish are consumed by the poor inhabitants of the Scotch and Irish coasts.* Still more are regularly collected for bait; the calamary is much used in the cod-fishery, off Newfoundland, and the limpet and whelk on our own coasts.

Many wild animals feed on shell-fish; the rat and the racoon seek for them on the sea-shore when pressed by hunger; the South-American otter, and the crab-eating opossum constantly resort to salt-marshes, and the sea, and prey on the mollusca; the great whale lives habitually on the small floating pteropods; sea-fowl search for the litoral species at every ebbing tide; whilst, in their own element, the marine kinds are perpetually devoured by fishes. The haddock is a "great conchologist;" and some good northern sea-shells have been rescued, unbroken, from the stomach of the cod; whilst even the strong valves of the *cyprina* are not proof against the teeth of the cat-fish *(anarhicas).*

They even fall a prey to animals much their inferiors in sagacity; the star-fish swallows the small bivalve entire, and dissolves the animal out of its shell; and the bubble-shell *(phyline),* itself predacious, is eaten both by star-fish and sea-anemone *(actinia).*

The land-snails afford food to many birds, especially to the thrush tribe; and to some insects, for the luminous larva of the glow-worm lives on them, and some of the large predacious beetles *(e. g. carabus violaceus* and *goerius olens),* occasionally kill slugs.

The greatest enemies of the *mollusca,* however, are those of their own nation; scarcely one-half the shelly tribes graze peacefully on sea-weed, or subsist on the nutrient particles which the sea itself brings to their mouths; the rest browse on living zoophytes, or prey upon the vegetable-feeders.

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* See Hugh Miller's "Scenes and Legends of the North of Scotland."

Yet in no class is the instinct of "self-preservation" stronger, nor the means of defence more adequate; their shells seem expressly given to compensate for the slowness of their movement, and the dimness of their senses. The cuttle-fish escapes from attack by swimming backwards and beclouding the water with an inky discharge; and the sea-hare *(aplysia)* pours out, when irritated, a copious purple fluid, formerly held to be poisonous. Others rely on passive resistance, or on concealment for their safety. It has been frequently remarked that molluscs resemble the hue and appearance of the situation they frequent; thus, the limpet is commonly overgrown with *balani* and sea-weed, and the ascidian with zoophytes, which form an effectual disguise; the *lima* and *modiola* spin together a screen of grotto-work. One ascidian *(a. cochligera)* coats itself with shell-sand, and the carrier-trochus cements shells and corals to the margin of its habitation, or so loads it with pebbles, that it looks but like a little heap of stones.

It must be confessed that the instincts of the shell-fish are of a low order, being almost limited to self-preservation, the escape from danger, and the choice of food. Their history offers none of those marvels which the entomologist loves to relate. An instance of something like social feeling has been observed in a Roman snail *(helix pomatia)* who, after escaping from a garden, returned to it in quest of his fellow-prisoner;—but the accomplished naturalist who witnessed the circumstance hesitated to record a thing so unexampled. The limpet, too, if we may trust the observations of Mr. Robert, of Lyme Regis, is fond of home, or at least possesses a knowledge of topography, and returns to the same roost after an excursion with each tide. Professor Forbes has immortalized the sagacity of the razor-fish, who submits to be salted in his hole, rather than expose himself to be caught, after finding that the enemy is lying in wait for him.

On the other hand, Mr. Bowerbank has a curious example of "instinct at fault," in the fossil spine of a sea-urchin, which appears to have been drilled by a carnivorous gasteropod!

We have spoken of shell-fish as articles of food, but they have other uses, even to man; they are the toys of children, who hear in them the roaring of the sea; they are the pride of "collectors"—whose wealth is in a cone or "wentle-trap;"* and they are the ornaments of barbarous tribes. The Friendly-islander wears the orange-cowry as a mark of chieftanship (*Stutchbury*), and the New Zealander polishes the *elenchus* into an ornament more brilliant than the "pearl ear-drop" of classical or modern times. (*Clarke.*) One of the most beautiful substances in nature is the shell-opal, formed of the remains of the ammonite. The forms and colours of shells (as of all other natural objects), answer some particular purpose, or obey some general law; but besides this, there is much that seems specially intended for our study, and calculated to call forth enlightened admiration. Thus the tints of many shells are concealed during life by a dull external coat, and the pearly halls of the nautilus are seen by no other eyes than ours. Or descending to mere "utility," how many tracts of coast are destitute of limestone, but abound in shell-banks which may be burned into lime; or in shell-sand, for the use of farmers.†

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* The extravagant prices that have been given for rare shells, are less to be regretted, because they have induced voyagers to collect. Mere shell-collecting, however, is no more *scientific* than pigeon-fancying, or the study of old china. For *educational* purposes the best shells are the *types* of genera, or species which illustrate particular points of structure; and, fortunately for students, the prices are much diminished of late years. A *Carinaria* once "worth 100 guineas" (Sowerby) is now worth 1s. only; a Wentle-trap which fetched 40 guineas in 1701 (Rumphius) was worth only 20 guineas in 1753, and may now be had for 5s.! The *Conus gloria-maris* has fetched £50 more than once, and *Cypræa* umbilicata has been sold for £30 this year, 1850.

† Shell-sand is only beneficial on peaty soils, or heavy clay land. It sometimes hardens into limestone, as on the coast of Devon; and at Guadaloupe, where it contains litoral shells and human skeletons of recent date.

Not much is known respecting the individual duration of the shell-fish, though their length of life must be very variable. Many of the aquatic species are annuals, fulfilling the cycle of their existence in a single year; whole races are entombed in the wintry tide of mud that grows from year to year in the beds of rivers, and lakes, and seas; thus, in the Wealden clay we find layer above layer of small river-snails, alternating with thin strata of sediment, the index of immeasureably distant years. Dredgers find that whilst the adults of some shell-fish can be taken at all seasons, others can be obtained late in the autumn or winter only; those caught in spring and summer being young, or half-grown; and it is a common remark that *dead* shells (of some species) can be obtained of a larger size than any that we find alive, because they attain their full-growth at a season when our researches are suspended. Some species require part of two years for their full development; the young of the *doris* and *eolis* are born in the summer time, in the warm shallows near the shore; on the approach of winter they retire to deeper water, and in the following spring return to the tidal rocks, attain their full-growth early in the summer, and after spawning-time disappear.

The land-snails are mostly biennial; hatched in the summer and autumn, they are half-grown by the winter-time, and acquire their full-growth in the following spring or summer. In confinement, a garden-snail will live for six or eight years; but in their natural state it is probable that a great many die in their second winter, for clusters of empty shells may be found, adhering to one another, under ivied walls, and in other sheltered situations; the animals having perished in their hybernation. Some of the spiral sea-shells live a great many years, and tell their age in a very plain and interesting manner, by the number of fringes *(varices)* on their whirls; the contour of the *ranella* and *murex* depends on the regular recurrence of these ornaments, which occur after the same intervals in well-fed individuals, as in their less fortunate kindred. The Ammonites appear, by their *varices*, or periodic mouths (pl. III., fig. 3), to have lived and continued growing for many years.

Many of the bivalves, like the mussel and cockle, attain their full-growth in a year. The oyster continues enlarging his shell by annual "shoots," for four or five years, and then ceases to grow outwards; but very aged specimens may be found, especially in a fossil state, with shells an inch or two in thickness. The giant-clam *(tridacna)*, which attains so large a size that poets and sculptors have made it the cradle of the sea-goddess,—must enjoy an unusual longevity; living in the sheltered lagoons of coral-islands, and not discursive in its habits, the corals grow up around, until it is often nearly buried by them; but although there seems to be no certain limit to its life (though it may live a century for all that we know), yet the time will probably come when it will be overgrown by its neighbours, or choked with sediment.

The fresh-water molluscs of cold climates bury themselves during winter, in the mud of their ponds and rivers; and the land-snails hide themselves in the ground, or beneath moss and dead leaves. In warm climates they become torpid during the hottest and driest part of the year.

Those genera and species which are most subject to this "summer sleep," are remarkable for their tenacity of life; and numerous instances have been recorded of their importation from distant countries, in a living state. In June, 1850, a living pond-mussel was sent to Mr. Gray, from Australia, which had been more than a year out of water.* The pond-snails (*ampullariæ*) have been found alive in logs of mahogany from Honduras (Mr. Pickering); and M. Caillaud carried some from Egypt to Paris, packed in saw-dust. Indeed, it is not easy to ascertain the limit of their endurance; for Mr. Laidlay having placed a number in a drawer for this purpose, found them alive after *five*

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* "It was alive 498 days after it was taken from the pond; and in the interim had been only twice for a few hours in water, to see if it was alive."—*Rev. W. O. Newnham.*

years, although in the warm climate of Calcutta. The *cyclostomas,* which are also *operculated,* are well known to survive imprisonments of many months; but in the ordinary land-snails such cases are more remarkable. Some of the large tropical *bulimi,* brought by Lieutenant Graves from Valparaiso, revived after being packed, some for thirteen, others for twenty months. In 1849, Mr. Pickering received from Mr. Wollaston a basket-full of Madeira snails (of twenty or thirty different species), three-fourths of which proved to be alive, after several months' confinement, including a sea-voyage. Mr. Wollaston has himself told us that specimens of two Madeira snails (*helix papilio* and *tectiformis*) survived a fast and imprisonment in pill-boxes, of two years and a half, and that a large number of the small *helix turricula,* brought to England at the same time, were *all* living after being inclosed in a dry bag for a year and a half.

But the most interesting example of resuscitation occurred to a specimen of the Desert snail, from Egypt, chronicled by Dr. Baird.* This individual was fixed to a tablet in the British Museum, on the 25th of March, 1846; and on March 7th, 1850, it was observed that he must have come out of his shell in the interval (as the paper had been discoloured, apparently in his attempt to get away); but finding escape impossible, had again retired, closing his aperture with the usual glistening film; this led to his immersion in tepid water, and marvellous recovery. He is now (March 13th, 1850) alive and flourishing, and has sat for his portrait. (Fig. 2.)

The permanency of the shell-bearing races is effectually provided for by their extreme fecundity; and though exposed to a hundred dangers in their early life, enough survive to re-people the land and sea abundantly. The spawn of a single *doris* may contain 600,000 eggs (Darwin); a river-mussel has been estimated to produce 300,000 young in one season, and the oyster cannot be much less prolific. The land-snails have fewer enemies, and, fortunately, lay fewer eggs.

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* An. Nat. Hist. 1850.

Lastly, the *mollusca* exhibit the same instinctive care with insects and the higher animals, in placing their eggs in situations where they will be safe from injury, or open to the influences of air and heat, or surrounded by the food which the young will require. The tropical *bulimi* cement leaves together, to protect and conceal their large, bird-like, eggs; the slugs bury theirs in the ground; the oceanic-snail attaches them to a floating raft; and the argonaut carries them in her frail boat. The horny capsules of the whelk are clustered in groups, with spaces pervading the interior, for the free passage of sea-water; and the nidamental ribbon of the *doris* and *eolis* is attached to a rock, or some solid surface from which it will not be detached by the waves. The river-mussel and *cyclas* carry their parental care still further, and nurse their young in their own mantle, or in a special *marsupium*, designed, like that of the opossum, to protect them until they are strong enough to shift for themselves.

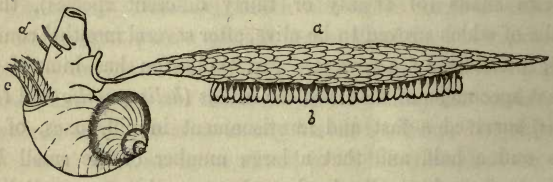

Fig. 9. *Ianthina with its raft.*

If any one imbued with the spirit of Paley or Chateaubriand, should study these phenomena, he might discover more than the "barren facts" which alone appear, without significance, to the unspiritual eye; he would see at every step fresh proofs of the wisdom and goodness of God, who thus manifests his greatness by displaying the same care for the maintenance of his feeblest creatures, as for the well-being of man, and the stability of the world.

CHAPTER IV.

STRUCTURE AND PHYSIOLOGY OF THE MOLLUSCA.

MOLLUSCOUS animals possess a distinct nervous system, instruments appropriated to the five senses, and muscles by which they execute a variety of movements. They have organs, by which food is procured and digested,—a heart, with arteries and veins, through which their colourless fluids circulate,—a breathing-organ,—and in most instances, a protecting shell. They produce eggs; and the young generally pass through one preparatory, or larval, stage.

The nervous system, upon which sensation and the exercise of muscular motion depend, consists of a brain or principal *centre*, and of various nerves possessing distinct properties: the *optic* nerves are only sensible of light and colours; the *auditory* nerves convey impressions of sound; the *olfactory*, of odours; the *gustatory*, of flavours; whilst the nerves of touch or feeling are widely diffused, and indicate in a more general way the presence of external objects. The nerves by which motion is produced, are distinct from these, but so accompany them as to appear like parts of the same cords. Both kinds of nerves cease to act when their connection with the centre is interrupted or destroyed. There is reason to believe, that most of the movements of the lower animals result from the reflection of external stimulants (like the process of *breathing* in man), without the intervention of the will.*

In the *mollusca*, the principal part of the nervous system is a ring surrounding the throat *(œsophagus)*, and giving off nerves to different parts of the body. The points from which the nerves radiate, are enlargements, termed centres *(ganglia)*, those on the sides and upper part of the ring represent the brain, and supply nerves to the eyes, tentacles, and mouth; other centres, connected with the lower side of the œsophageal ring, send nerves to the foot, viscera, and respiratory organ. In the bivalves, the branchial centre is the most conspicuous, and is situated on the posterior adductor muscle. In the tunicaries, the corresponding nervous centre may be seen between the two orifices in the muscular tunic. This scattered condition of the nervous centres is eminently characteristic of the entire sub-kingdom.

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* See Müller's Elements of Philosophy, edited by Dr. Baly.

Organs of special sense.—Sight. The eyes are two in number, placed on the front or sides of the head; sometimes they are *sessile,* in others stalked, or placed on long pedicels *(ommatophora).* The eyes of the cuttle-fishes resemble those of fishes in their large size and complicated structure. Each consists of a strong fibrous globe *(slerotic),* transparent in front *(cornea),* with the opposite internal surface *(retina)* covered by a dark pigment which receives the rays of light. This chamber is occupied by an aqueous humour, a crystalline lens, and a vitreous humour, as in the human eye. In the *strombidœ,* the eye is not less highly organised, but in most of the *gasteropoda* it has a more simple structure, and perhaps only possesses sensibility of light without the power of distinct vision. The larval bivalves have also a pair of eyes in the normal position (fig. 30) near the mouth; but their development is not continued, and the adults are either eyeless, or possess merely rudimentary organs of vision, in the form of black dots (*ocelli*) along the margin of the mantle.* These supposed eyes have been detected in a great many bivalves, but they are most conspicuous in the scallop, which has received the name of *argus* from Poli, on this account (fig. 10).

In the tunicaries similar *ocelli* are placed between the tentacles which surround the orifices.

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* "Each possesses a cornea, lens, choroid and nerve; they are, without doubt, organs of vision."—*Garner.*

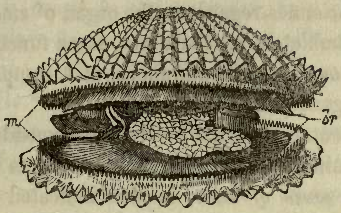

Fig. 10. *Pecten varius.**

Sense of Hearing. In the highest cephalopods, this organ consists of two cavities in the rudimentary cranium which protects the brain ; a small calcarious body or *otolithe* is suspended in each, as in the vestibular cavities of fishes.† Similar auditory capsules occur near the base of the tentacles in the *gasteropoda*, and they have been detected, by the vibration of the otolithes, in many bivalves and brachiopods. With the exception of *tritonia* and *eolis*, none of mollusca have been observed to emit sounds. (*Grant*).

Sense of Smell, This faculty is evidently possessed by the cuttle-fishes and gasteropods; snails discriminate their food by it, slugs are attracted by offensive odours, and many of the marine *zoophaga* may be taken with animal baits. In the pearly nautilus, there is a hollow plicated process beneath each eye,

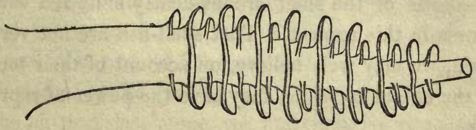

Fig. 11. *Tentacle of a Nudibranch.*‡

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* *Pecten varius*, L., from a specimen dredged by Mr. Bowerbank, off Tenby ; *m*, the pallial curtains ; *br*, the branchiœ.

† In the Octopods, there is a foramen near the eye, and in some of the Calamaries a plicated organ, which M. D'Orbigny regards as an external ear.

‡ Fig. 11. Tentacle of *Eolis coronata*, Forbes, from Alder and Hancock.

which M. Valenciennes regards as the organ of smell[*]. Messrs. Hancock and Embleton attribute the same function to the lamellated tentacles of the nudibranchs, and compare them with the olfactory organs of fishes.

The labial tentacles of the bivalves are considered to be organs for discriminating food, but in what way is unknown (fig. 18. *l. t.*)[*] The *sense of taste*, is also indicated rather by the habits of the animals, and their choice of food, than by the structure of a special organ. The *acephala* appear to exercise little discrimination in selecting food, and swallow anything that is small enough to enter their mouths, including living animalcules, and even the sharp *spicula* of sponges. In some instances, however, the oral orifice is well guarded, as in *pecten* (fig. 10.) In the *Encephala*, the tongue is armed with spines, employed in the comminution of the food, and cannot possess a very delicate sense. The more ordinary and diffused *sense of touch* is possessed by all the mollusca; it is exercised by the skin, which is everywhere soft and lubricous, and in a higher degree by the fringes of the bivalves (fig. 12), and by the filaments and tentacles (*vibracula*) of the gasteropods; the eye-pedicels of the snail are evidently endowed with great sensitiveness in this respect. That shell-fish are not very sensible of pain, we may well believe, on account of their tenacity of life, and the extent to which they have the power of reproducing lost parts.

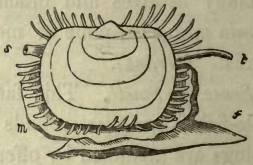

Fig. 12. *Lepton Squamosum.*[†]

Muscular System. The muscles of the *mollusca* are principally connected with the skin, which is exceedingly contractile in every part. The snail affords a remarkable, though familiar instance, when it draws in its eye-stalks, by a process like the inversion of a glove-finger; the branching gills of some of the sea-slugs, and the tentacles of the cuttle-fishes, are also eminently contractile.*

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[*] Mr. Owen regards the membraneous *lamellæ* between the oral tentacles and in front of the mouth, as the seat of the olfactory sense. *See Fig.* 44.

[†] Fig. 12. *Lepton sqaumosum Mont.*, from a drawing by Mr. Alder, in the British Mollusca; copied by permission of Mr. Van Voorst.

The inner tunic of the *ascidians* (fig. 8, *t.*) presents a beautiful example of muscular tissue, the crossing fibres having much the appearance of basket-work; in the transparent *salpians*, these fibres are grouped in flat bands, and arranged in characteristic patterns. In this class (*tunicata*) they act only as *sphincters* (or circular muscles), and by their sudden contraction expel the water from the branchial cavity. The muscular foot of the bivalves is extremely flexible, having layers of circular fibres for its protrusion, (fig. 18. *f*) and longitudinal bands for its retraction (fig. 30 *h*); its structure and mobility has been compared to that of the human tongue. In the burrowing shell-fish (such as *solen*), it is very large and powerful, and in the boring species, its surface is studded with silicious particles (*spicula*), which render it a very efficient instrument for the enlargement of their cells. (*Hancock.*) In the attached bivalves it is not developed, or exists only in a rudimentary state, and is subsidiary to a gland which secretes the material of those threads with which the mussel and *pinna* attach themselves. (Fig. 13.) These threads are termed the *byssus;* the plug of the *anomia*, and the pedicel of *terebratula* are modifications of the *byssus.*

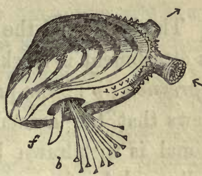

Fig. 13. *Dreissena.*†

In the cuttle-fishes alone, we find muscles attached to internal cartilages which represent the bones of *vertebrate* animals; the muscles of the arms are inserted in a cranial cartilage, and those of the fins in the lateral cartilages, the equivalents of the pectoral fins of fishes.

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* The muscular fibres of shell-fish do not exhibit the transverse stripes which characterize *voluntary* muscles in the higher animals.

† Fig. 13. *Dreissena polymorpha* (Pallas sp.) from the Surrey timber-docks. *f*, foot. *b*, byssus.

Muscles of a third kind are attached to the shell. The valves of the oyster (and other *mono-myaries*) are connected by a single muscle; those of the *cytherea* (and other *di-myaries*), by two; the contraction of which brings the valves together. They are hence named *adductors;* and the part of the shell to which they are attached is always indicated by scars. (Fig. 14, *a. a'*).

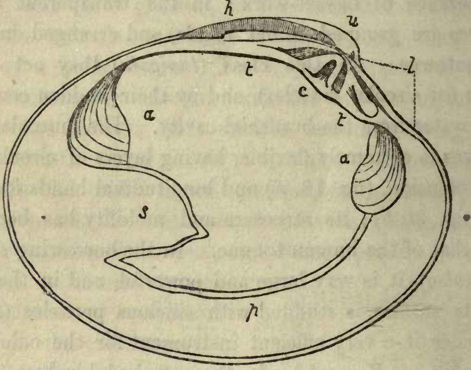

Fig. 14. *Left valve of Cytherea chione.**

The border of the mantle is also muscular, and the place of its attachment is marked in the shell by a line called the *pallial impression* (*p*); the presence of a bay, or *sinus* (*s*), in this line, shews that the animal had retractile siphons; the foot of the animal is withdrawn by *retractor* muscles also attached to the shell, and leaving small scars near those of the adductors (Fig. 30*).

The gasteropods withdraw into their shells when alarmed, by a shell-muscle, which passes into the foot, or is attached to the *operculum;* its impression is horse-shoe-shaped in the limpet, as also in *navicella*, *concholepas*, and the nautilus; it becomes deeper with age. In the spiral univalves, the scar is less conspicuous, being situated on the *columella*, and sometimes divided, forming two spots. It corresponds to the posterior *retractors* in the bivalves.

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* Fig. 14. *Cytherea chione*, L., coast of Devon, (original); *h*, the hinge ligament; *u*, the umbo; *l*, the lunule; *c*, cardinal tooth; *t t'*, lateral teeth; *a*, anterior adductor; *a'*, posterior adductor; *p*, pallial impression; *s*, sinus, occupied by retractor of the siphons.

Digestive system. This part of the animal economy is all-important in the *radiate* classes, and scarcely of less consequence in the *mollusca*. In the ascidians (fig. 8, *i*), the alimentary canal is a convoluted tube, in part answering to the *œsophagus*, and in part to the intestine; the stomach is distinguished by longitudinal folds, which increase its extent of surface; it receives the secretion of the liver by one or more apertures. In those bivalves, which have a large foot, the digestive organs are concealed in the upper part of that organ; the mouth is unarmed, except by two pairs of soft membranous *palpi*, which look like accessory gills (fig. 18. *l. t.*) The ciliated arms of the brachipods, occupy a similar position (figs. 4, 5, 6), and are regarded as their equivalents. The encephalous mollusca are frequently armed with horny jaws, working vertically like the mandibles of a bird; in the land-snails, the upper jaw is opposed only by the denticulated tongue, whilst the limneïds have two additional horny jaws, acting laterally. The tongue is muscular, and armed with recurved spines (or *lingual teeth*), arranged in a great variety of patterns, which are eminently characteristic of the genera.* Their teeth are amber-coloured, glossy, and translucent; and being silicious (they are insoluble in acid), they can be used like a file, for the abrasion of very hard substances. With them the limpet rasps the stony nullipore, the whelk bores holes in other shells, and the cuttle-fish doubtless uses its tongue in the same manner as the cat. The tongue, or lingual ribbon, usually forms a triple band, of which the central part is called the *rachis*, and the lateral tracts *pleuræ*, the rachidian teeth sometimes form a single series, overlapping each other, or there are lateral teeth on each side of a median series. The teeth on the pleuræ are termed *uncini;* they are extremely numerous in the plant-eating gasteropods. (Fig. 15. A.)*

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* The preparation of the lingual ribbon as a permanent microscopic object, requires some nicety of manipulation, but the arrangement of the teeth may be seen by merely compressing part of the animal between two pieces of glass.

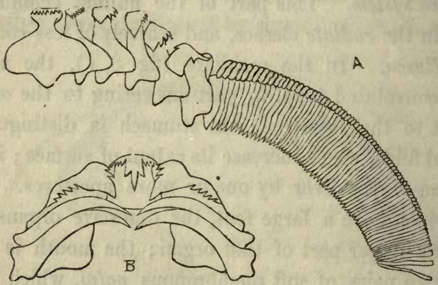

Fig. 15. *Lingual Teeth of Mollusca.*

Sometimes the tongue forms a short semi-circular ridge, contained between the jaws; at others, it is extremely elongated, and when withdrawn, its folds extend backwards to the stomach. The lingual ribbon of the limpet is longer than the whole animal; the tongue of the whelk has 100 rows of teeth; and the great slug has 160 rows, with 180 teeth in each row.

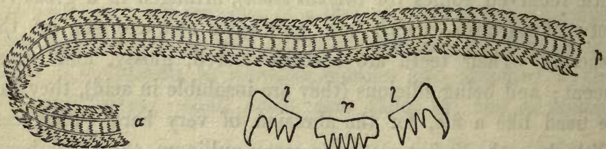

Fig. 16. *Tongue of the Whelk.*†

The front of the tongue is frequently curved, or bent quite over; it is the part of the instrument in use, and its teeth are often broken or blunted. The posterior part of the lingual ribbon usually has its margins rolled together, and united, forming a tube, which is presumed to open gradually. The new teeth are developed from behind forwards, and are brought successively into use, as in the sharks and rays amongst fishes. In the *bulladæ* the *rachis* of the tongue is unarmed, and the business of communicating the food is transferred to an organ which resembles the gizzard of a fowl, and is often paved with calcarious plates, so large and strong as to crush the small shell-fish which are swallowed entire. In the *aplysia*, which is a vegetable-feeder, the gizzard is armed with numerous small plates and spines. The stomach of some bivalves contains an instrument called the "crystalline stylet," which is conjectured to have a similar use. In the cephalopods there is a crop in which the food may accumulate, as well as a gizzard for its trituration.

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* Fig. 15. A. Lingual teeth of *trochus cinerarius* (after Lovén). Only the median tooth, and the (5) lateral teeth, and (90) *uncini* of one side of a single row are represented. B. One row of the lingual teeth of *cypræa europæa;* consisting of a median tooth, and three *uncini* on each side of it.

† Fig. 16. Lingual ribbon of *buccinum undatum* (original), from a preparation communicated by Wm. Thomson, Esq., of King's College.

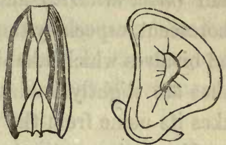
Fig. 17. *Gizzard of Bulla.**

The *liver* is always large in the mollusca (fig. 10); its secretion is derived from arterial blood, and is poured either into the stomach, or the commencement of the intestine. In the nudibranchs, whose stomachs are often remarkably branched, the liver accompanies all the gastric ramifications, and even enters the respiratory papillæ on the backs of the eolids. The existence of a *renal* organ has been ascertained in most classes; in the bivalves it was detected by the presence of uric acid. The intestine is more convoluted in the herbivorous than in the carnivorous tribes: in the bivalves and in *haliotis* it passes through the ventricle of the heart; its termination is always near the respiratory aperture (or excurrent orifice, when there are two*), and the excrements are carried away by the water which has already passed over the gills.

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* Fig. 17. Gizzard of *bulla lignaria* (original). Front and side view of a half-grown specimen, with the part nearest the head of the animal downwards; in the front view the plates are in contact. The *cardiac* orifice is in the centre, in front; the *pyloric* orifice is on the posterior dorsal side, near the small transverse plate.

Besides the organs already mentioned, the encephalous mollusks are always furnished with well-developed *salivary glands*, and some have a rudimentary *pancreas ;* many have also special glands for the secretion of coloured fluids, such as the purple of the *murex*, the violet liquid of *ianthina* and *aplysia*, the yellow of the *bulladæ*, the milky fluid of *eolis*, and the inky secretion of the cuttle-fishes. A few exhale peculiar odours, like the garlic-snail (*helix alliaria*) and *eledone moschata.* Many are phosphorescent, especially the floating tunicaries (*salpa* and *pyrosoma*), and bivalves which inhabit holes (*pholadidæ*). Some of the cuttle-fishes are slightly luminous ; and one land-slug, the *phosphorax*, takes its name from the same property.

Circulating system. The *mollusca* have no distinct absorbent system, but the product of digestion (*chyle*) passes into the general abdominal cavity, and thence into the larger veins, which are perforated with numerous round apertures. The circulating organs are the heart, arteries, and veins ; the blood is colourless, or pale bluish white. The *heart* consists of an *auricle* (sometimes divided into two), which receives the blood from the gills ; and a muscular *ventricle* which propels it into the arteries of the body. From the capillary extremities of the arteries it collects again into the veins, circulates a second time through the respiratory organ, and returns to the heart as arterial blood. Besides this *systemic* heart, the circulation is aided by two additional *branchial* hearts in the cuttle-fishes ; and by four in the *brachiopoda.* Mr. Alder has counted from 60 to 80 pulsations per minute in the nudibranchs, and 120 per minute in a *vitrina.* Both the arteries and veins form occasionally wide spaces, or

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* In most of the gasteropods the intestine returns upon itself, and terminates on the right side, near the head. Occasionally it ends in a perforation more or less removed from the margin of the aperture, as in *trochotoma*, *fissurella*, *macrochisma*, and *dentalium.* In *chiton* the intestine is straight, and terminates posteriorly.

sinuses; in the cuttle-fishes the œsophagus is partly or entirely surrounded by a venous *sinus;* and in the *acephala* the viceral cavity itself forms part of the circulating system.

The circulation in the tunicaries presents a most remarkable exception to the general rule, for their blood ebbs and flows in the same vessels, as it was supposed to do in the human veins before the time of Harvey. In the transparent *salpæ* it may be seen passing from the heart into vessels connected with the *viscera* and tunics, and thence into the branchial vessels; but when this has continued for a time, the movement ceases, and recommences in the opposite direction, passing from the heart to the gill and thence to the system. (*Lister.*) In the compound tunicaries, there is a common circulation through the connecting medium, in addition to the individual currents.

Aquiferous canals. Sea-water is admitted to the visceral cavity of many of the mollusks (as it is also in radiate animals), by minute canals, opening externally in the form of pores. These *aquiferous pores* are situated either in the centre of the creeping disc, as in *cypræa, conus*, and *ancillaria;* or at its margin, as in *haliotis, doris*, and *aplysia.* In the cuttle-fishes, they are variously placed, on the sides of the head, or at the bases of the arms; some of them conduct to the large sub-orbital pouches, into which the tentacles are retracted.

Respiratory system. The respiratory process consists in the exposure of the blood to the influence of air, or water containing air; during which oxygen is absorbed and carbonic acid liberated. It is a process essential to animal life, and is never entirely suspended, even during hybernation. Those air-breathers that inhabit water are obliged to visit the surface frequently; and stale water is so inimical to the water-breathers, that they soon attempt to escape from the confinement of a glass or basin, unless the water is frequently renewed.* In general, fresh-water is immediately fatal to marine species, and salt-water to those which properly inhabit fresh; but there are some which affect brackish water, and many which endure it to a limited extent. The depth at which shell-fish live, is influenced by the quantity of oxygen which they require; the most active and energetic races live only in shallow water, or near the surface; those found in very deep water are the lowest in their instincts, and are specially organized for their situation. Some water-breathers require only moist sea-air, and a bi-diurnal visit from the tide,—like the periwinkle, limpet, and *kellia;* whilst many air-breathers live entirely in the water or in damp places by the water-side. In fact, the nature of the respiratory process is the same, whether it be aquatic or aërial, and it is essential in each case that the surface of the breathing-organ should be preserved moist. The process is more complete in proportion to the extent and minute sub-division of the vessels, in which the circulating fluid is exposed to the revivifying influence.

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* When aquatic plants are kept in the same glass with water-breathing snails, a balance is produced; which enables both to live without change of water.

The land-snails (*pulmonifera*), have a lung, or air-chamber, formed by the folding of the mantle, over the interior of which the pulmonary vessels are distributed; this chamber has a round orifice, on the right side of the animal, which opens and closes at irregular intervals. The air in this cavity seems to renew itself with sufficient rapidity (by the law of diffusion), without any special mechanism.

In the aquatic shell-fish, respiration is performed by the mantle, or by a portion of it specialized, and forming a gill (*branchia*). It is effected by the mantle alone in one family of tunicaries (*pelonaiadæ*), in all the *brachiopoda*, and in one family of gasteropods (*actæonidæ*).

In most of the *tunicata*, the breathing organ forms a distinct *sac* lining the muscular tunic, or mantle (fig. 8. *b.*); this sac has only one external aperture, and conducts to the mouth, which is situated at its base. It is a sieve-like structure, and its inner surface is clothed with vibratile cilia* which create a perpetual current, setting in through the (branchial) orifice, escaping through the meshes of the net, and passing out by the anal orifice of the outer tunics. The regularity of this current is interrupted only by spasmodic contractions of the mantle, occurring at irregular intervals, by which the creature spirts out water from *both* orifices, and thus clears its cavity of such accumulated particles as are rejected by the mouth; and too large to escape through the branchial pores. In the salpians, these contractions are *rythmical,* and have the effect of propelling them backwards. In the ordinary bivalves, the gills form two membranous plates on each side of the body; the muscular mantle is still sometimes united, forming a chamber with two orifices, into one of which the water flows, whilst it escapes from the other; there is a third opening in front, for the foot, but this in no wise influences the branchial circulation. Sometimes the orifices are drawn out into long tubes, or *siphons*, especially in those shell-fish which burrow in sand. (Figs. 19 and 7.)

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* From *cilium*, an eyelash; they are only visible under favourable circum-

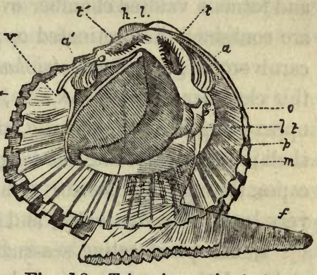

Fig. 18. *Trigonia pectinata.**

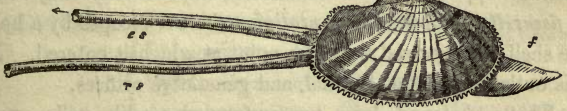

Fig. 19. *Bivalve with long siphons.*†

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stances, with the aid of a microscope ; but the currents they cause are easily made perceptible by dropping fine sand into the water over them.

* *Trigonia pectinata,* Lam. (original). Brought from Australia by the late Captain Owen Stanley. The gills are seen in the centre through the transparent mantle. *o,* mouth; *l t,* labial tentacles; *f,* foot; *v,* vent.

† Fig. 19. *Psammobia vespertina,* Chemn. after Poli, reduced one half. The arrows indicate the direction of the current. *r s,* respiratory siphon. *e s,* excurrent siphon.

Those bivalves which have no siphons, and even those in which the mantle is divided into two lobes, are provided with valves or folds which render the respiratory channels just as complete in effect. These currents are not in any way connected with the opening and closing of the valves, which is only done in moving; or in efforts to expel irritating particles.*

In some of the *gasteropoda* the respiratory organs form tufts, exposed on the back and sides (as in the *nudibranches*), or protected by a fold of the mantle (as in the *inferobranches* and *tectibranches* of Cuvier). But in most the mantle is inflected, and forms a vaulted chamber over the back of the neck, in which are contained the pectinated or plume-like gills (fig. 61). In the carnivorous gasteropods (*siphonostomata*) the water passes into this chamber through a *siphon*, formed by a prolongation of the upper margin of the mantle, and protected by the *canal* of the shell; after traversing the length of the gill, it returns and escapes through a posterior siphon, generally less developed, but very long in *ovulum volva*, and forming a tubular spine in *typhis.*

In the plant-eating sea-snails (*holostomata*), there is no true siphon, but one of the "neck-lappets" is sometimes curled up and performs the same office, as in *paludina* and *ampullaria* (fig. 84). The in-coming and out-going currents in the branchial chamber, are kept apart by a valve-like fringe, continued from the neck-lappet. The out-current is still more effectually isolated in *fissurella*, *haliotis*, and *dentalium*, where it escapes by a hole in the shell, far removed from the point at which it entered. Near this outlet are the anal, renal, and generative orifices.

The cephalopods have two or four plume-like gills, symmetrically placed in a branchial chamber, situated on the under-side of the body; the opening is in front, and occupied by a *funnel*, which, in the nautilus, closely resembles the siphon of the *paludina*, but has its edges united in the cuttle-fishes. The free edge of the mantle is so adapted that it allows the water to enter the branchial chamber on each side of the funnel; its muscular walls then contract and force the water through the funnel, an arrangement chiefly subservient to locomotion.* Mr. Bowerbank has observed, that the *eledone* makes twenty respirations per minute, when resting quietly in a basin of water.

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* If a river-mussel be placed in a glass of water, and fine sand let fall gently over its respiratory orifices, the particles will be seen to rebound from the vicinity of the upper aperture, whilst they enter the lower one rapidly. But as this kind of food is not palatable, the creature will soon give a plunge with its foot, and closing its valves, spirt the water (and with it the sand) from both orifices; the motion of the foot is, of course, intended to change its position.

In most instances, the water on the surface of the gills is changed by ciliary action alone; in the *cephalopods* and *salpians*, it is renewed by the alternate expansion and contraction of the respiratory chamber, as in the *vertebrate* animals.

The respiratory system is of the highest importance in the economy of the mollusca, and its modifications afford most valuable characters in classification. It will be observed that the Cuvierian *classes* are based on a variety of particulars, and are very unequal in importance; but the *orders* are characterized by their respiratory conditions, and are of much more nearly equal value.

	Orders.	*Classes.*
ENCEPHALA	Dibranchiata. Owen.	Cephalopoda.
	Tetrabranchiata. Owen.	
	Nucleobranchiata. Bl.	Gasteropoda.
	Prosobranchiata. M. Edw.	
	Pulmonifera. Cuv.	
	Opisthobranchiata. M. Edw.	
	Aporobranchiata. Bl.	Pteropoda.
ACEPHALA	Palliobranchiata. Bl.	Brachiopoda.
	Lamellibranchiata. Bl.	Conchifera.
	Heterobranchiata. Bl.	Tunicata.

The Shell. The relation of the shell to the breathing-organ is very intimate; indeed, it may be regarded as a *pneumo-skeleton*, being essentially a calcified portion of the mantle, of which the breathing-organ is at most a specialised part.*

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* A very efficient means of locomotion in the slender pointed calamaries, which dart backwards with the recoil, like rockets.

The shell is so characteristic of the mollusca that they have been commonly called "testacea" (from *testa* "a shell"), in scientific books; and the popular name of "shell-fish," though not quite accurate, cannot be replaced by any other epithet in common use. In one whole class, however, and in several families, there is nothing that would be popularly recognised as a shell.

Shells are said to be *external* when the animal is contained in them, and *internal* when they are concealed in the mantle; the latter, as well as the shell-less species, being called *naked* mollusks.

Three-fourths of the *mollusca* are *univalve*, or have but one shell;. the others are mostly *bivalve*, or have two shells; the *pholads* have accessory plates, and the shell of *chiton* consists of eight pieces. Most of the *multivalves* of old authors were articulate animals (*cirripedes*), erroneously included with the *mollusca*, which they resemble only in outward appearance.

All, except the argonaut, acquire a rudimental shell before they are hatched, which becomes the *nucleus* of the adult shell; it is often differently shaped and coloured from the rest of the shell, and hence the *fry* are apt to be mistaken for distinct species from their parents.

In *cymba* (fig. 20) the nucleus is large and irregular; in *fusus antiquus* it is cylindrical; in the *pyramidellidæ* it is oblique; and it is spiral in *carinaria*, *atlanta*, and many limpets, which are symmetrical when adult.

The rudimentary shell of the *nudibranchs* is shed at an early age, and never replaced. In this respect the molluscan shell differs entirely from the shell of the crab and other articulate animals, which is periodically cast off and renewed.

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* In its most reduced form the shell is only a hollow cone, or plate, protecting the breathing organ and heart, as in *limax*, *testacella*, *carinaria*. Its peculiar features always relate to the condition of the breathing-organ; and in *terebratula* and *pelonaia* it becomes identified with the gill. In the nudibranchs the vascular mantle performs wholly or in part the respiratory office. In the cephalopods the shell becomes complicated by the addition of a distinct, internal, chambered portion (*phragmocone*), which is properly a *visceral* skeleton; in *spirula* the shell is reduced to this part.

In the bivalves the embryonic shell forms the *umbo* of each valve; it is often very unlike the after-growth, as in *unio pictorum*, *cyclas henslowiana* and *pecten pusio*. In attached shells like the oyster and anomia the umbo frequently presents an exact imitation of the surface to which the young shell originally adhered.

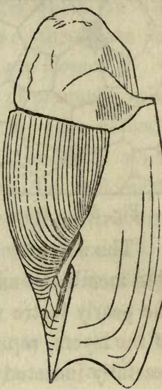

Fig. 20. *Cymba.*[*]

Shells are composed of carbonate of lime, with a small proportion of animal matter. The source of this lime is to be looked for in their food. Modern inquiries into organic chemistry have shown that vegetables derive their elements from the mineral kingdom (air, water, and the soil), and animals theirs from the vegetable. The sea-weed filters the salt-water, and separates lime as well as organic elements; and lime is one of the most abundant mineral matters in land plants. From this source the *mollusca* obtain lime in abundance, and, indeed, we find frequent instances of shells becoming unnaturally thickened through the superabundance of this earth in their systems. On the other hand, instances occur of thin and delicate-shelled varieties, in still, deep water, or on clay bottoms; whilst in those districts which are wholly destitute of lime, like the lizard in Cornwall, and similar tracts of magnesian-silicate in Asia Minor, there are no mollusca. (*Forbes.*)

The texture of shells is various and characteristic. Some, when broken, present a dull lustre like marble or china, and are termed *porcellanous;* others are pearly or *nacreous;* some have a *fibrous* structure; some are *horny*, and others *glassy* and *translucent.*

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[*] Fig. 20. *Cymba proboscidalis*, Lam., from a very young specimen in the cabinet of Hugh Cuming, Esq., from Western Africa.

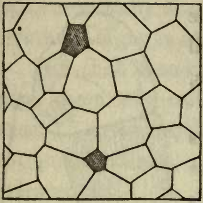

Fig. 21. *Pinna.*

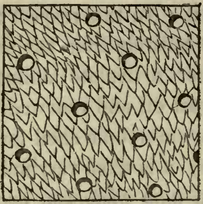

Fig. 22. *Terebratula.*

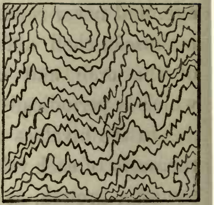

Fig. 23. *Pearl.*[*]

The *nacreous* shells are formed by alternate layers of very thin membrane and carbonate of lime, but this alone does not give the pearly lustre which appears to depend on minute undulations of the layers, represented in fig. 23. This lustre has been successfully imitated on engraved steel buttons. Nacreous shells, when polished, form "mother of pearl;" when digested in weak acid, they leave a membraneous residue which retains the original form of the shell. This is the most easily destructible of shell-textures, and in some geological formations we find only casts of the nacreous shells, whilst those of fibrous texture are completely preserved.

Pearls are produced by many bivalves, especially by the Oriental pearl-mussel (*avicula margaritifera*), and one of the British river-mussels (*unio margaritiferus*). They are caused by particles of sand, or other foreign substances, getting between the animal and its shell; the irritation causes a deposit of nacre, forming a projection on the interior, and generally more brilliant than the rest of the shell. Completely spherical pearls can only be formed loose in the muscles, or other soft parts of the animal. The Chinese obtain them artificially, by introducing into the living mussel foreign substances, such as pieces of mother-of-pearl fixed to wires, which thus become coated with a more brilliant material.

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[*] Figs. 21, 22, 23. Magnified sections of shells, from Dr. Carpenter. Fragments of shell ground very thin, and cemented to glass slides with Canada balsam, are easily prepared, and form curious microscopic objects. A great variety of them may be procured of Mr. C. M. Topping, of Pentonville.

Similar prominences and concretions—pearls which are not *pearly*—are formed inside porcellanous shells; these are as variable in colour as the surfaces on which they are formed.*

The *fibrous* shells consist of successive layers of prismatic cells containing translucent carbonate of lime; and the cells of each successive layer correspond, so that the shell, especially when very thick (as in the fossil *inoceramus* and *trichites*), will break up vertically, into fragments, exhibiting on their edges a structure like arragonite, or satin-spar. Horizontal sections exhibit a cellular net-work, with here and there a dark cell, which is empty. (fig. 21.)

The oyster has a *laminated* structure, owing to the irregular accumulation of the cells in its successive layers, and breaks up into horizontal plates.

In the boring-shells (*pholadidæ*) the carbonate of lime has an atomic arrangement like arragonite, which is considerably harder than calcarious spar; in other cases the difference in hardness depends on the proportion of animal matter, and the manner in which the layers are aggregated.†

In many bivalve shells there occurs a minute *tubular structure*, which is very conspicuous in some sections of pinna and oyster-shell.

The *brachiopoda* exhibit a characteristic structure by which the smallest fragment of their shells may be determined; it consists of elongated and curved cells, matted together, and often perforated by circular holes, arranged in quincunx order (fig. 22).

But the most complex shell-structure is presented by the *porcellanous* gasteropoda. These consist of three strata which readily separate in fossil shells, on account of the removal of their animal cement. In fig. 24, *a* represents the outer, *b* the middle, and *c* the inner stratum; they may be seen, also, in fig. 25.

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* They are pink in *turbinellus* and strombus; white in *ostrea*; white or glassy, purple or black in mytilus; rose-coloured and translucent in *pinna*. (*Gray*.)

† The *specific gravity* of floating shells (such as *argonanta* and *ianthina*) is lower than that of any others. (*De la Beche*.)

Each of these three strata is composed of very numerous vertical plates, like cards placed on edge; and the direction of the plates is sometimes transverse in the central stratum, and lengthwise in the outer and inner (as in *cypræa*, *cassis*, *ampullaria*, and *bulimus*), or longitudinal in the middle layer, and transverse in the others (*e. g. conus*, *pyrula*, *oliva*, and *voluta*).

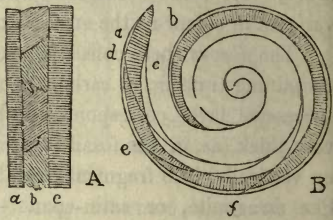

Fig. 24. *Sections of a cone.**

Each *plate*, too, is composed of a series of prismatic cells, arranged obliquely (45°), and their direction being changed in the successive plates, they cross each other at right angles. Tertiary fossils best exhibit this structure, either at their broken edge, or in polished sections.† *(Bowerbank).*

The argonaut-shell, and the bone of the cuttle-fish, have a peculiar structure; and the *Hippurite* is distinguished by a cancellated texture, unlike any other shell, except, perhaps, some of the *cardiaceæ* and *chamaceæ*.

Epidermis. All shells have an outer coat of animal matter called the "epidermis" (or *periostracum*), sometimes thin and transparent, at others thick and opaque. It is thick and olive-coloured in all fresh-water shells, and in many *arctic* sea-shells (*e. g. cyprina* and *astarte*); the colours of the land-shells often depend on it; sometimes it is silky as in *helix sericea,* or fringed with hairs, as in *trichotropis;* in the whelk and some species of *triton* and *conus* it is thick and rough like coarse cloth, and in some *modiolas* it is drawn out into long beard-like filaments.

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* Sections of *conus ponderosus*, Brug., from the Miocene of the Touraine. A, longitudinal section of a fragment, B, complete horizontal section; *a*, outer layer; *b*, middle; *c*, inner layer; *d*, *e*, *f*, lines of growth.

† It is necessary to bear in mind that fossil shells are often *pseudomorphous*, or mere casts, in spar or chalcedony, of cavities once occupied by shells; such are the fossils found at Blackdown, and many of the London clay fossils at Barton. The Palæozoic fossils are often *metamorphic*, or have undergone a re-arrangement of their particles, like the rocks in which they occur.

In the cowry and other shell-fish with large mantle lobes, the epidermis is more or less covered up by an additional layer of shell deposited externally.

The *epidermis* has life, but not sensation, like the human scarf-skin; and it protects the shell against the influence of the weather, and chemical agents; it soon fades, or is destroyed, after the death of the animal, in situations where, whilst living, it would have undergone no change. In the bivalves it is organically connected with the margin of the mantle.

It is most developed in shells which frequent damp situations, amongst decaying leaves, and in fresh-water shells. All fresh-waters are more or less saturated with carbonic-acid gas, and in limestone countries hold so much lime in solution as to deposit it in the form of *tufa* on the mussels and other shells.* But in the absence of lime to neutralise the acid, the water acts on the shells, and would dissolve them entirely if it were not for their protecting epidermis. As it is we can often recognise fresh-water shells by the erosion of those parts where the epidermis was thinnest, namely, the points of the spiral shells and the *umbones* of the bivalves, those being also the parts longest exposed. Specimens of *melanopsis* and *bithinia* become truncated again and again in the course of their growth, until the adults are sometimes only half the length they should be, and the discoidal *planorbis* sometimes becomes perforated by the removal of its inner whirls; in these cases the animal closes the break in its shell with new layers. Some of the unios thicken their umbones enormously, and form a layer of animal matter with each new layer of shell, so that the river-action is arrested at a succession of steps.

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* As at Tisbury, in Wiltshire, where remarkable specimens of *anodons* were obtained by the late Miss Benett.

FORMATION AND GROWTH OF THE SHELL.

The shell, as before stated, is formed by the *mantle* of the shell-fish, indeed, each layer of it was once a portion of the mantle, either in the form of a simple membrane, or as a layer of cells; and each layer was successively calcified (or hardened with carbonate of lime) and thrown off by the mantle to unite with those previously formed. Being extra-vascular it has no inherent power of repair. (*Carpenter.*)

The epidermis and cellular structures are formed by the margin (or *collar*) of the mantle; the membranous and nacreous layers, by the thin and transparent portion which contains the viscera; hence we find the pearly texture only as a lining inside the shell, as in the *nautilus,* and all the *aviculidæ* and *turbinidæ.*

If the margin of a shell is fractured during the life-time of the animal, the injury will be completely repaired by the reproduction both of the epidermis and of the outer layer of shell with its proper colour. But if the apex is destroyed, or a hole made at a distance from the aperture, it will merely be closed with the material secreted by the visceral mantle. Such inroads are often made by boring worms and shells, and even by a sponge (*cliona*) which completely mines the most solid shells. In Mr. Gray's cabinet is the section of a cone, in whose apex a colony of *lithodomi*

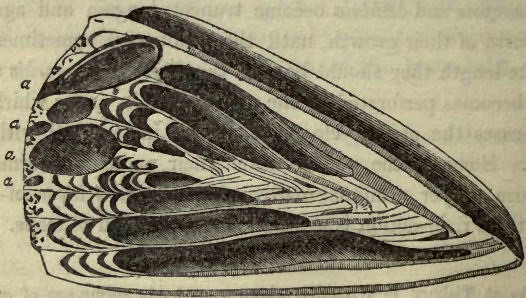

Fig. 25. *Section of a cone perforated by lithodomi.*

had settled, compelling the animal to contract itself, faster even than it could form shell to fill up the void.

Lines of growth. So long as the animal continues growing, each new layer of shell extends beyond the one formed before it; and, in consequence, the external surface becomes marked with *lines of growth.* During winter, or the season of rest which corresponds to it, shells cease to grow; and these periodic resting-places are often indicated by interruptions of the otherwise regular lines of growth and colour, or by still more obvious signs. It is probable that this pause, or cessation from growth, extends into the breeding season; otherwise there would be two periods of growth, and two of rest in each year. In many shells the growth is uniform; but in others each stage is finished by the development of a fringe, or ridge (*varix*), or of a row of spines, as in *tridacna* and *murex*. (*Owen, Grant.*)

Adult characters. The attainment of the full-growth proper to each species is usually marked by changes in the shell.

Some bivalves, like the oyster, and *gryphæa* (fig. 26), continue to increase in thickness long after they have ceased to grow outwards; the greatest addition is made to the lower valve, especially near the umbo; and in the *spondylus* some parts of the mantle secrete more than others, so that cavities, filled with fluid, are left in the substance of the shell.

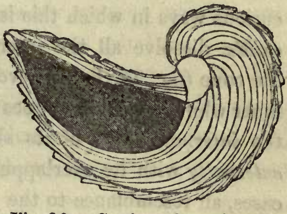

Fig. 26. *Section of gryphæa.**

The adult *teredo* and *fistulana* close the end of their burrows; the *pholadidea* fills up the great *pedal* opening of its valves; and the *aspergillum* forms the porous disk from which it takes its name. Sculptured shells, particularly *ammonites*, and species of *rostellaria* and *fusus*, often become plain in the last part of their growth. But the most characteristic change is the thickening and contraction of the aperture in the univalves. The young cowry (fig. 27) has a thin, sharp lip, which becomes curled inwards, and enormously thickened and toothed in the adult; the *pteroceras* (pl. 4, fig. 3) developes its scorpion-like claws, only when full-grown; and the land-snails form a thickened lip, or narrow their aperture with projecting processes, so that it is a marvel how they pass in and out, and how they can exclude their eggs, (*e. g.* pl. 12, fig. 4, *anastoma;* and fig. 5, *helix hirsuta*).

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* Fig. 26. Section of *gryphæa incurva*, Sby. Lias, Dorset, (original; diminished one half), the upper valve is not much thickened; the interior is filled with lias.

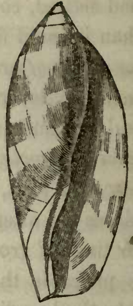
Fig. 27. *Young Cowry.**

Yet at this time they would seem to require more space and accommodation in their houses than before, and there are several curious ways in which this is obtained. The *neritidæ* and *auriculidæ* dissolve all the internal spiral column† of their shells; the cone (fig. 24, B,) removes all but a paper-like portion of its inner whirls; the cowry goes still further, and continues removing the *internal* layers of its shell-wall, and depositing new layers *externally* with its overlapping mantle (fig. 76), until, in some cases, all resemblance to the young shell is lost in the adult.

The power which mollusks possess of dissolving portions of their own shells, is also exhibited by the *murices*, in removing those spines from their whirls which interfere with their growth; and by the *purpuræ* and others in wearing away the wall of their aperture. The agency in these cases is supposed to be chemical.

Decollated shells. It frequently happens that as spiral shells become adult they cease to occupy the upper part of their cavity; the space thus vacated is sometimes filled with solid shell, as in *magilus;* or it is partitioned off, as in *vermetus*, *euomphalus*, *turritella* and *triton* (fig. 62). The deserted apex is sometimes very thin, and becoming dead and brittle, it breaks away, leaving the shell truncated, or decollated. This happens constantly with the *truncatellæ*, *cylindrellæ*, and *bulimus decollatus ;* amongst the fresh-water shells it depends upon local circumstances, but is very common with *pirena* and *cerithidea*.

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* *Cypræa testudinaria*, L., young.

† This is sometimes done by the hermit-crab to the shells it occupies.

Forms of shells. These will be described particularly under each class; enough has been said to show that in the molluscan shell (as in the vertebrate skeleton) indications are afforded o many of the leading affinities and structural peculiarities of the animal. It may sometimes be difficult to determine the genus of a shell, especially when its form is very simple; but this results more from the imperfection of our technicalities and systems, than from any want of co-ordination in the animal and its shell.

Monstrosities. The whirls of spiral shells are sometimes separated by the interference of foreign substances, which adhere to them when young; the garden-snail has been found in this condition, and less complete instances are common amongst sea-shells. Discoidal shells occasionally become spiral (as in specimens of *planorbis* found at Rochdale), or irregular in their growth, owing to an unhealthy condition. The discoidal *ammonites* sometimes show a slight tendency to become spiral, and more rarely become unsymmetrical, and have the keel on one side, instead of in the middle.

All attached shells are liable to interference in their growth, and malformations consequent on their situation in cavities, or from coming in contact with rocks. The *dreissena polymorpha* distorts the other fresh-water mussels by fastening their valves with its *byssus ;* and *balani* sometimes produce strange protuberances on the back of the cowry, to which they have attached themselves when young.*

In the miocene tertiaries of Asia Minor, Professor Forbes discovered whole races of *neritina*, *paludina*, and *melanopsis*, with whirls ribbed or keeled, as if through the unhealthy influence of brackish water. The fossil periwinkles of the Norwich Crag are similarly distorted, probably by the access of fresh-water; parallel cases occur at the present day in the Baltic.

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* In the British Museum there is a *helix terrestris* (chemn.) with a small stick passing through it, and projecting from the apex and umbilicus. Mr. Pickering has, in his collection, a *helix hortensis* which got entangled in a nut-shell when young, and growing too large to escape, had to endure the incubus to the end of its days.

Reversed shells. Left-handed, or reversed varieties of spiral shells have been met with in some of the very common species, like the whelk and garden-snail. *Bulimus citrinus* is as often sinistral as dextral; and a reversed variety of *fusus antiquus* was more common than the normal form in the *pliocene* sea. Other shells are constantly reversed, as *pyrula perversa*, many species of *pupa*, and the entire genera, *clausilia*, *cylindrella*, *physa*, and *triphoris*. Bivalves less distinctly exhibit variations of this kind; but the attached valve of *chama* has its *umbo* turned to the right or left indifferently; and of two specimens of *lucina childreni* in the British Museum, one has the right, the other the left valve flat.

The colours of shells are usually confined to the surface beneath the epidermis, and are secreted by the border of the mantle, which often exhibits similar tints and patterns (*e. g. voluta undulata*, fig. 73). Occasionally the inner strata of porcellanous shells are differently coloured from the exterior, and the makers of shell-cameos avail themselves of this difference to produce white or rose-coloured figures on a dark ground.*

The secretion of colour by the mantle depends greatly on the action of light; shallow-water shells are, as a class, warmer and brighter coloured than those from deep water; and bivalves which are habitually fixed or stationary (like *spondylus* and *pecten pleuronectes*) have the upper valve richly tinted, whilst the lower one is colourless. The backs of most spiral shells are darker than the under sides; but in *ianthina* the base of the shell is habitually turned upwards, and is deeply dyed with violet. Some colours are more permanent than others; the red spots on the *naticas* and *nerites* are commonly preserved in tertiary and oolitic fossils, and even in one example (of n. subcostata schl.) from *Devonian* limestone. *Terebratula hastata*, and some *pectens* of the carboniferous period, retain their markings; the *orthoceras anguliferus* of the *Devonian* beds has zig-zag bands of colour; and a terebratula of the same age, from arctic North America,* is ornamented with several rows of dark red spots.

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* Cameos in the British Museum, carved on the shell of *cassis cornuta*, are white on an orange ground; on *c. tuberosa*, and *madagascariensis*, white upon dark claret-colour; on *c. rufa*, pale salmon-colour on orange; and on *strombus gigas*, yellow on pink. By filing some of the olives (*e. g. oliva utriculus*) they may be made into very different coloured shells.

The operculum. Most spiral shells have an *operculum*, or lid, with which to close the aperture when they withdraw for shelter (see gasteropoda). It is developed on a particular lobe at the posterior part of the foot, and consists of horny layers, some times hardened with shelly matter (fig. 28).

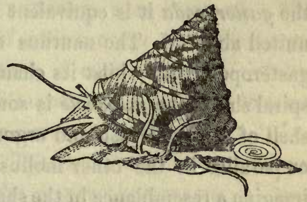

Fig. 28. *Trochus ziziphinus.*†

It has been considered by Adanson, and more recently by Mr. Gray, as the equivalent of the dextral valve of the conchifera; but however similar in appearance, its anatomical relations are altogether different. In position it represents the *byssus* of the bivalves (Lovén); and in function it is like the plug with which unattached specimens of *bysso-arca* close their aperture. (*Forbes.*)

Homologies of the shell.‡ The shell is so simple a structure that its modifications present few points for comparison; but even these are not wholly understood, or free from doubt. The

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* Presented to the British Museum by Sir John Richardson.

† *Trochus ziziphinus,* from the original, taken in Pegwell Bay abundantly. This species exhibits small tentacular processes, neck-lappets, side-lappets, tentacular filaments, and an operculigerous lobe.

‡ Parts which correspond in their real nature—(their origin and development)—are termed *homologous;* those which agree merely in appearance, or office, are said to be *analogous.*

bivalve shell may be compared to the outer tunic of the *ascidian*, cut open and converted into separable valves. In the *conchifera* this division of the mantle is vertical, and the valves are right and left. In the *brachiopoda* the separation is horizontal, and the valves are dorsal and ventral. The *monomyarian* bivalves lie habitually on one side (like the *pleuronectidæ* among fishes); and their shells, though *really* right and left, are termed "upper" and "lower" valves. The univalve shell is the equivalent of *both* valves of the bivalve. In the *pteropoda* it consists of dorsal and ventral plates, comparable with the valves of *terebratula*. In the *gasteropoda* it is equivalent to both valves of the *conchifera* united above.* The nautilus shell corresponds to that of the gasteropod; but whilst its chambers are shadowed forth in many spiral shells, the *siphuncle* is something additional; and the entire shell of the cuttle-fish and argonaut† have no known equivalent or parallel in the other molluscous classes. The student might imagine a resemblance in the shell of the *orthoceras* to a *back-bone;* but the true homologue of the vertebrate skeleton is found in the neural and muscular cartilages of the cephalopod; whilst its *phragmocone* is but the representative of the calcarious axis (or *splanchno-skeleton*) of a coral, such as *amplexus* or *siphonophyllia*.

Temperature and hybernation. Observations on the *temperature* of the *mollusca* are still wanted; it is known, however, to vary with the medium in which they live, and to be sometimes a degree or two higher or lower than the external temperature; with snails (in cool weather), it is generally a degree or two higher.

The *mollusca* of temperate and cold climates are subject to *hybernation;* during which state the heart ceases to beat, respiration is nearly suspended, and injuries are not healed. They also *æstivate,* or fall into a summer sleep when the heat is great; but in this the animal functions are much less interrupted. (*Muller.*)

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* Compare *fissurella* or *trochus* (fig. 28) with *lepton squamosum* (fig. 12). The disk of *hipponyx* is analogous to the ventral plate of hyalæa and terebratula.

† The argonaut shell is compared by Mr. Adams to the nidamental capsules of the *whelk;* a better analogue would have been found in the *raft* of the *ianthina*, which is secreted by the *foot* of the animal, and serves to *float* the egg-capsules.

Reproduction of lost parts. It appears from the experiments of Spallanzani, that snails, whose ocular tentacles have been destroyed, reproduce them completely in a few weeks; others have repeated the trial with a like result. But there is some doubt whether the renewal takes place if the brain of the animal be removed as well as its horns. Madame Power has made similar observations upon various marine snails, and has found that portions of the foot, mantle, and tentacles, were renewed. Mr. Hancock states that the species of *eolis* are apt to make a meal off each other's *branchiæ,* and that, if confined in stale water, they become sickly and lose those organs; in both cases they are quickly renewed under favourable circumstances.

Reproduction by gemmation. The social and compound tunicaries resemble zoophytes, in the power they possess of budding out new individuals, and thus of multiplying their communities indefinitely, as the leaves on a tree. This gemmation takes place only at particular points, so that the whole assemblages are aggregated in characteristic patterns. The buds of the social tunicaries are supported at first by their parents, those of the compound families by the general circulation, until they are in a state to contribute to the common weal.

Viviparous reproduction. This happens in a few species of gastropods, through the retention of the eggs in the oviduct, until the young have attained a considerable growth. It also *appears* to take place in the acephalans, because their eggs generally remain within some part of the shell of the parent until hatched.

Alternate generation. Amongst the tunicaries an example is found of regulated diversity in the mode of reproduction. The salpians produce long chains of embryos, which, unless broken by accident, remain connected during life;—each individual of these compound specimens produces *solitary young,* often so unlike the parent as to have been described and named by naturalists as distinct species;—these solitary salpians again produce chains of embryos, like their grand-parents. (*Chamisso.*)

Oviparous reproduction. The sexes are distinct in the most highly organised (or *diœcious*) mollusca; they are united in the (*monœcious*) land-snails, pteropods, brachiopods, tunicaries, and in part of the conchifers. The prosobranchs pair; but in the diœcious acephalans and cuttle-fishes, the *spermatozoa* are merely discharged into the water, and are inhaled with the respiratory currents by the other sex. The monœcious land-snails require reciprocal union; the limneïds unite in succession, forming floating chains.

The *eggs* of the land-snails are separate, and protected by a shell, which is sometimes albuminous and flexible, at others calcarious and brittle; those of the fresh-water species are soft, mucous, and transparent. The spawn of the sea-snails consists of large numbers of eggs, adhering together in masses, or spread out in the shape of a strap or ribbon, in which the eggs are arranged in rows; this *nidamental ribbon* is sometimes coiled up spirally, like a watch-spring, and attached by one of its edges. The eggs of the carnivorous gasteropods are inclosed in tough albuminous capsules, each containing numerous germs; these are deposited singly, or in rows, or agglutinated in groups, equalling the parent animal in bulk (fig. 70). The nidamental capsules of the cuttle-fish are clustered like grapes, each containing but one embryo; those of the calamary are groupe

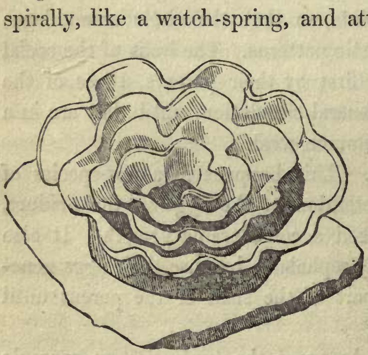

Fig. 29. *Spawn of Doris.**

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* Nidamental ribbon of *Doris Johnstoni.* (*Alder and Hancock.*)

in radiating masses, each elongated capsule containing 30 or 40 ova. The material with which the eggs are thus cemented together, or enveloped, is secreted by the *nidamental gland*, an organ largely developed in the female gasteropods and cephalopods (fig. 43, n).

Development. The molluscan *ovum* consists of a coloured yolk (*vitellus*), surrounded by albumen. On one side of the yolk is a pellucid spot, termed the *germinal vesicle,* having a spot or *nucleus* on its surface. This germinal vesicle is a nucleated cell, capable of producing other cells like itself; it is the essential part of the egg, from which the *embryo* is formed; but it undergoes no change without the influence of the *spermatozoa.*[*] After impregnation, the germinal vesicle, which then subsides into the centre of the yolk, divides spontaneously into two; and these again divide and subdivide into smaller and still smaller globules, each with its pellucid centre or nucleus, until the whole presents a uniform granular appearance. The next step is the formation of a ciliated *epithelium* on the surface of the embryonic mass; movements in the albumen become perceptible in the vicinity of the *cilia*, and they increase in strength, until the embryo begins to revolve in the surrounding fluid.[†]

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[*] No instance of "partheno-genesis" is known among the *mollusca;* the most "equivocal" case on record is that related by Mr. Gaskoin. A specimen of *helix lactea,* Müll., from the South of Europe, after being *two years* in his cabinet, was discovered to be still living; and on being removed to a plant-case it revived, and six weeks afterwards had produced twenty young ones!

[†] According to the observations of Professor Lovén (on certain bivalve mollusca), the ova are excluded immediately after the inhalation of the spermatozoa, and apparently from their influence; but impregnation does not take place within the ovary itself. The spermatozoa of *cardium pygmæum* were distinctly seen to penetrate, in succession, the outer envelopes of the ova, and arrive at the vitellus, when they disappeared. With respect to the "germinal vesicle;" according to Barry, it first approaches the inner surface of the vitelline membrane, in order to receive the influence of the spermatozoa; it then retires to the centre of the yolk, and undergoes a series of spontaneous subdivisions. In M. Lovén's account, it is said to "burst" and par-

Up to this point nearly the same appearances are presented by the eggs of all classes of animals,—they manifest, so far, a complete "unity of organization." In the next stage, the development of an organ, fringed with stronger *cilia*, and serving both for locomotion and respiration, shews that the embryo is a *molluscous animal;* and the changes which follow soon point out the particular *class* to which it belongs. The rudimentary *head* is early distinguishable, by the black eye-specks; and the *heart*, by its pulsations. The digestive and other organs are first "sketched out," then become more distinct, and are seen to be covered with a transparent shell. By this time the embryo is able to move by its own muscular contractions, and to swallow food; is is therefore "hatched," or escapes from the egg.

The embryo tunicary quits the egg in the cloacal cavity of its parent, and is at this time provided with a swimming instrument, like the tail of the tadpole, and with processes by which it attaches itself as soon as it finds a suitable situation.

The young bivalves also are hatched before they leave their parent, either in the gill cavity or in a special sac attached to the gills (as in *cyclas*), or in the interspaces of the external branchial laminæ (as in *unio*). At first they have a swimming disk, fringed with long *cilia*, and armed with a slender tentacular filament (*flagellum*). At a later period this disk disappears progressively, as the labial palpi are developed; and they acquire a foot, and with it the power of spinning a byssus. They now

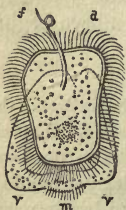

Fig. 30.*

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tially dissolve, whilst the egg remains in the ovary, and before impregnation; it then passes to the centre of the yolk, and undergoes the changes described by Barry, along with the yolk, whilst the *nucleus* of the germinal vesicle, or some body exactly resembling it, is seen occupying a small prominence on the surface of the vitelline membrane, until the metamorphosis of the yolk is completed, when it disappears, in some unobserved manner, without fulfilling any recognized purpose.

* Fig. 30. Very young fry of *crenella marmorata*, Forbes, highly magnified; *d*, disk, bordered with cilia: *f*, flagellum; *v v*, valves; *m*, ciliated mantle.

have a pair of eyes, situated near the labial tentacles (fig. 30*, *e*), which are lost at a further stage, or replaced by numerous rudimentary organs placed more favourably for vision, on the border of the mantle.

Most of the aquatic *gasteropoda* are very minute when hatched, and they enter life under the same form,—that which has been already referred to as permanently characteristic of the *pteropoda*. (Fig. 60.)

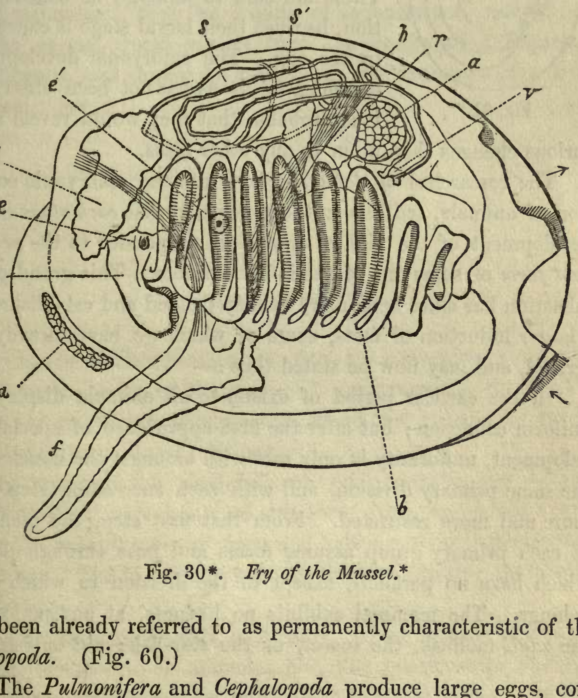

Fig. 30*. *Fry of the Mussel.**

The *Pulmonifera* and *Cephalopoda* produce large eggs, containing sufficient nutriment to support the *embryo* until it has attained considerable size and development; thus, the newly-born cuttle-fish has a shell half an inch long, consisting of several layers, and the *bulimus ovatus* has a shell an inch in length when hatched. (Fig. 31.) These are said to undergo no transformation, because their larval stage is concealed in the egg. The embryonic development of the cuttle-fishes has not been observed; it is probable that they would reveal more curious changes than occur in any other class.

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* Fig. 30*. Fry of *mytilus edulis*, after Lovén. *e*, eye; *e'*, auditory capsule; *l t*, labial tentacles; *s s'*, the stomach; *b*, branchiæ; *h*, heart; *v*, vent; *l*, liver; *r*, renal organ; *a*, anterior adductor; *a'*, posterior adductor; *f*, foot. The arrows indicate the incurrent and excurrent openings; between which the margins of the mantle are united in the fry.

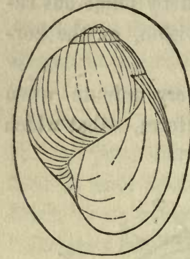

Fig. 31.*

The researches of *John Hunter*† into the embryonic condition of animals, led him to the conclusion that *each stage* in the development of the highest animals corresponded to the *permanent form* of some one of the inferior orders. This grand generalisation has since been more exactly defined and established by a larger induction of facts, some of which we have already described, and may now be stated thus:—

In the earliest period of existence all animals display one uniform condition; but after the first appearance of special development, uniformity is only met with amongst the members of the same primary division, and with each succeeding step it is more and more restricted. From that first step, the members of each primary group assume forms and pass through phases which have no parallels, except in the division to which each belongs. The mammal exhibits no likeness, at any period, to the *adult* mollusk, the insect, or the star-fish; but only to the ovarian stage of the invertebrata, and to more advanced stages of the classes formed upon its own type. And so also with the highest organized *mollusca;* after their first stage they resemble the simpler orders of their own sub-kingdom, but not those of any other group.

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* Egg and young of *bulimus ovatus,* Mull. sp., Brazil, from specimens in the collection of Hugh Cuming, Esq.

† "In his printed works the finest elements of system seem evermore to flit before him, twice or thrice only to have been seized, and after a momentary detention to have been again suffered to escape. At length, in the astonishing preparations for his museum, he constructed it, for the scientific apprehension, out of the unspoken alphabet of nature." (*Coleridge.*)

These are the views of Professor Owen—the successor of Hunter—by whom it has been most clearly shewn and steadfastly maintained, that the "unity of organization" manifested by the animal world results from the design of a Supreme Intelligence, and cannot be ascribed to the operation of a mechanical "law."

CHAPTER V.

CLASSIFICATION.

THE objects of classification are, *first*, the convenient and intelligible arrangement of the species;* and, *secondly*, to afford a summary, or condensed exposition, of all that is known respecting their structure and relations.

In studying the shell-fish, we find resemblances of two kinds. First, agreements of structure, form, and habits; and, secondly, resemblances of form and habits without agreement of structure. The first are termed relations of *affinity;* the second of *analogy*.

Affinities may be near, or remote. There is some amount of affinity common to all animals; but, like relationships amongst men, they are recognized only when tolerably close. Resemblances of structure which subsist from a very early age are presumed to imply original relationship; they have been termed

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* At least 12,000 recent, and 15,000 fossil species of molluscous animals are known.

genetic (or *histological*), and are of the highest importance. Those which are superinduced at a later period, are of less consequence.

Analogies. Modifications relating only to peculiar habits are called *adaptive;* or *teleological*, from their relation to final causes.* A second class of analogical resemblances are purely external and illusive; they have been termed *mimetic* (*Strickland*), and, by their frequency, almost justify the notion that a certain set of forms and colours are repeated, or represented in every class and family. In all artificial arrangements, these mimetic resemblances have led to the association of widely different animals in the same groups.† Particular forms are also *represented* geographically‡ and geologically,§ as well as systematically.

In all attempts to characterise groups of animals, we find, that in advancing from the smaller to the larger combinations, many of the most obvious external features become of less avail, and we are compelled to seek for more constant and comprehensive signs in the phases of embryonic development, and the condition of the circulating, respiratory, and nervous systems.

Species. All the specimens, or individuals, which are so much alike that we may reasonably believe them to have descended from a common stock, constitute a *species.* It is a particular provision for preventing the blending of species, that *hybrids* are always barren; and it is certain, in the case of shells, that a great many kinds have not changed in form, from the tertiary period to the present day,—a lapse of many thousand years,—and through countless generations. When individuals of the same brood differ in any respect, they are termed *varieties;* for example, one may be more exposed to the light, and become brighter coloured; or it may find more abundant food, and grow larger than the rest. Should these peculiarities become permanent at any place, or period,—should all the specimens on a particular island or mountain, or in one sea, or geological formation, differ from those found elsewhere,—such permanent variety is termed a *race;* just as, in the human species, there are white and coloured races. The species of some genera are less subject to variation than others; the *nuculæ,* for example, although very numerous, are always distinguishable by good characters. Other genera, like *ammonites, terebratula,* and *tellina,* present a most perplexing amount of variation, resulting from age, sex, supply of food, variety of depth, and of saltness in the water. And further, whilst in some genera every possible variety of form seems to have been called into existence, in others only a few, strikingly distinct forms, are known.

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* For example, the paper nautilus, from its resemblance to *carinaria*, was long supposed to be the shell of a nucleobranche, parasitically occupied by the "*ocythoë.*"

† E. g. Aporrhaïs with strombus, and ancylus with patella.

‡ Monoceros imbricatum and buccinum antarcticum take the place, in South America, of our common whelk and purple, and solen gladiolus and solen americanus of our solen siliqua and ensis.

§ The frequent recurrence of similar species in successive strata may lead beginners to attribute too much to the influence of time and external circumstances; but such impressions disappear with further experience.

Genera are groups of species, related by community of structure in all essential respects. The genera of bivalves have been characterised by the number and position of their hinge-teeth; those of the spiral univalves, by the form of their apertures; but these technical characters are only valuable so far as they indicate differences in the animals themselves.

Families are groups of genera, which agree in some more general characters than those which unite species into genera. Those which we have employed are mostly modifications of the artificial families framed by Lamarck, a plan which seemed more desirable, in the present state of our knowledge, than a subdivision into very numerous families, without assignable characters.

The *orders and classes* of mollusca have already been referred to; those now in use are all extremely natural.

It has been sometimes asserted that these groups are only scientific contrivances, and do not *really* exist in nature; but this is a false as well as a degrading view of the matter. The labours of the most eminent systematists have been directed to the discovery of the subordinate value of the characters derivable from every part of the animal organization; and, as far as their information enabled them, they have made their systems expressive "of all the highest facts, or generalisations, in natural history." (*Owen.*)

M. Milne Edwards has remarked, that the actual appearance of the animal kingdom is not like a well-regulated army, but like the starry heavens, over which constellations of various magnitude are scattered, with here and there a solitary star which cannot be included in any neighbouring group.

This is exceedingly true; we cannot expect our systematic groups to have equal numerical values,* but they ought to be of equal structural importance; and they will thus possess a *symmetry* of order, which is superior to mere numerical regularity.

All the most philosophic naturalists have entertained a belief that the development of animal forms has proceeded upon some regular plan, and have directed their researches to the discovery of that "reflection of the divine mind." Some have fancied that they have discovered it in a mystic number, and have accordingly converted all the groups into *fives.*† We do not undervalue these speculations, yet we think it better to describe things so far only as we know them.

Great difficulty has always been found in placing groups according to their affinities. This cannot be effected in—the way in which we are compelled to describe them—a single series; for each group is related to *all* the rest; and if we extend the representation of the affinities to very small groups, any arrangement on a plane surface would fail, for the affinities radiate in all directions, and the "net-work" to which Fabricius likened them, is as insufficient a comparison as the "chain" of older writers.*

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* The numerical development of groups is *inversely proportional to the bulk of the individuals composing them.* (*Waterhouse.*)

† The *quinarians* make out five molluscous classes, by excluding the *tunicata;* the same end would be attained in a more satisfactory manner by reducing the pteropods to the rank of an order, which might be placed next to the *opistho-branches.*

Chapter VI.

NOMENCLATURE.

The practice of using two names—generic and specific—for each animal, or plant, originated with Linnæus; therefore no scientific names date further back than his works. In the construction of these names, the Greek and Latin languages are preferred, by the common consent of all countries.

Synonyms. It often happens that a species is named, or a genus established, by more than one person, at different times, and in ignorance of each other's labours. Such duplicate names are called *synonyms;* they have multiplied amazingly of late, and are a stumbling-block and an opprobium in all branches of natural history.†

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* The quinary arrangement of the molluscous classes reminds us of the eastern emblem of eternity—the serpent holding its tail in its mouth.

The following diagram is offered as an improved *circular system:*—

[Fishes.]
Di-branchiata.
Nucleo- Tetra-
Opistho- Proso-
Aporo- Pulmo-
Pallio- Lamelli-
Hetero-branchiata.
[Zoophytes.]

† In Pfeiffer's *Monograph of the Helicidæ*, a family containing seventeen genera, no less than 330 *generic synonyms* are enumerated; to this list, Dr. Albers, of Berlin, has lately added *another hundred* of his own invention!

One very common estuary shell rejoices in the following variety of titles:—

Scrobicularia piperata (*Gmelin sp*).
Trigonella plana (*Da Costa*).
Mactra Listeri (*Auct*).
Mya Hispanica (*Chemnitz*).
Venus borealis (*Pennant*).
Lutraria compressa (*Lamarck*).
Arenaria plana (*Megerle*).

As regards *specific* names, the earliest ought certainly to be adopted,—with, however, the following exceptions:—

1. MS. names; which are only admitted by courtesy.
2. Names given by writers antecedent to Linnæus.
3. Names unaccompanied by a description or figure.
4. Barbarisms; or names involving error or absurdity,*

It is also very desirable that names having a general (European) acceptation, should not be changed, on the discovery of earlier names in obscure publications.

With respect to *genera*,—those who believe in their real existence, as "ideas of the creating mind," will be disposed to set aside many random appellations, given to particular shells without any clear enunciation of their characters; and to adopt later names, if bestowed with an accurate perception of the grounds which entitle them to generic distinction.†

Authority for specific names. The multiplication of synonyms having made it desirable to place the *authority* after each

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[*] This subject was investigated, and reported upon, by a committee of the British Association, in 1842; but the report was not sufficiently circulated.

[†] Several bad practices—against which there is, unhappily, no law—should be strongly discountenanced. First, the employment of names already in familiar use for other objects; such as *cidaris* (the title of a well-known genus of sea-urchins), for a group of spiral shells; and *arenaria* (a property of the botanists), for a bivalve. Secondly, the conversion of *specific* into *generic* titles, a process which has caused endless confusion; it has arisen out of the vain desire of giving new designations to old and familiar objects, and thus obtaining a questionable sort of fame.

name, another source of evil has arisen; for several naturalists (fancying that the *genus-maker*, and not the *species-maker*, should enjoy this privilege) have altered or divided almost every genus, and placed their signatures as the authorities for names given half a century or a century before, by Linnæus or Bruguiere.* British naturalists have disowned this practice, and agreed to distinguish, by the addition of "sp.," the authorities for those specific names whose generic appellations have been changed.

Types. The type of each genus *should be* that species in which the characters of its group are best exhibited, and most evenly balanced. (*Waterhouse.*) It has, however, been customary to take as the type, that species which the genus-maker placed first on his list; although by so doing there is risk of adopting an *aberrant* form, or one which very feebly represents the group, of which it is an obscure member.

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* The authorities appended to specific names, are supposed to indicate an amount of work done in the determination and description of the species; when, therefore, the real author's name is suppressed, and a spurious one substituted, the case looks very like an attempt to obtain credit under false pretences.

ABBREVIATIONS.

Etym., etymology. *Syn.*, synonym. *Distr.*, distribution.
M.S., manuscript, i. e., *unpublished.*
Sp., species. Brit. M., (in the) British Museum.
Distr., Norway—New Zealand; including all intermediate seas.
Fossil, lias—chalk; implies that the genus existed in these, and all intervening strata. Chalk —; means that the genus commenced in the chalk, and has existed ever since.
Depth; — 50 fms.; genus found at all depths between low-water and 50 fathoms. A fathom is six feet.

$\frac{1}{4}$ one-fourth the real size; $\frac{4}{1}$ magnified four times.
Lat., breadth. *Long.*, length. *Alt.*, height or thickness.
Unc., (uncia) an inch. *Lin.*, (linea) a line, the $\frac{1}{12}$ of an inch.
Mill., millimetre, the twenty-fifth part of an inch.

MANUAL OF THE MOLLUSCA.

CLASS I. CEPHALOPODA.

THE cuttle-fishes, though excluded by dealers from the list of shell-fish, are the most remarkable, and, rightly considered, the most interesting of any; whilst their relatives, the *nautili* and *ammonites*, are unmatched for the symmetry and wondrous architecture of their pearly shells.

The principal locomotive organs of the *cephalopods*, are attached to the head, in the form of muscular arms or tentacles;* in addition to which, many have fins; and all can propel themselves by the forcible expulsion of water from their respiratory chamber.

Unlike most of the *mollusca*, they are symmetrical animals, having their right and left sides equally developed; and their shell is usually straight, or coiled in a vertical plane. The nautilus and argonaut alone (of the living tribes) have external shells; the rest are termed "naked cephalopods," because the shell is internal. They have powerful jaws, acting vertically, like the mandibles of birds; the tongue is large and fleshy, and part of its surface is sentient, whilst the rest is armed with recurved spines; their eyes are large, and placed on the sides of the head; their senses appear to be very acute. All are marine; and predatory, living on shell-fish, crabs, and fishes.

The nervous system is more concentrated than in the other *mollusca;* and the brain is protected by a cartilage. The respiratory organs consist of two or four plume-like gills, placed symmetrically on the sides of the body, in a large branchial cavity, opening forwards on the *under*† side of the head; in the middle of this opening is placed the *siphon* or *funnel*. The sexes are always distinct; but the males are much less numerous than the females, and in many species, at present unknown. They are divided into two orders, the names of which are derived from the number of the *branchiæ*.

ORDER I. DIBRANCHIATA, Owen.

Animal swimming; naked. *Head* distinct. *Eyes* sessile, prominent. *Mandibles* horny (Pl. I., fig. 2). *Arms* 8 or 10, provided with suckers. *Body* round or elongated, usually with a pair of *fins; branchiæ* two, furnished with muscular ventricles; *ink-gland* always present; *parietes* of the *funnel* entire.

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* M. Schultze compares the arms of the cephalopods to the oral filaments of *myxine*.

† According to the established usage, we designate that the *under* or *ventral* side of the body, on which the funnel is placed. But if the cuttle fishes are compared with the nucleobranches, or the nautilus with the holostomatous gasteropods, their external analogies seem to favour an opposite conclusion.

Shell internal (except in *argonauta*), horny or shelly, with or without air-chambers.

The typical forms of the cuttle-fishes were well described by Aristotle, and have been repeatedly examined by modern naturalists; yet, until Professor Owen demonstrated the existence of a second order of cephalopods, departing from all the abovementioned characters, it was not clearly understood how inseparably the organisation of the cuttle-fishes was connected with their condition as *swimming mollusca*, breathing by *two* gills.

The characters which co-exist with the two gills, are the internal rudimentary shell, and the substitution of other means of escape and defence, than those which an external shell would have afforded; viz.: powerful arms, furnished with suckers; the secretion of an inky fluid, with which to cloud the water and conceal retreat; more perfect organs of vision; and superadded branchial hearts, which render the circulation more vigorous.*

The *suckers* (*antlia* or *acetabula*), form a single or double series, on the inner surface of the arms. From the margin of each cup, the muscular fibres converge to the centre, where they leave a circular cavity, occupied by a soft *caruncle*, rising from it like the piston of a syringe, and capable of retraction when the sucker is applied to any surface. So perfect is this mechanism for effecting adhesion, that while the muscular fibres continue retracted, it is easier to tear away the limb than to detach it from its hold.† In the decapods, the base of the *piston* is surrounded by a horny dentated hoop; which in the uncinated calamaries, is folded, and produced into a long sharp claw.

The *ink-bag* (fig. 33), is tough and fibrous, with a thin silvery outer coat; it discharges its contents through a duct which opens near the base of the funnel. The ink was formerly used for writing (*Cicero*), and in the preparation of *sepia*;‡ and from its indestructible nature, is often found in a fossil state.

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* In a few species, which have no fins, the arms are webbed. In the only kind which has an external shell, it is confined to the female sex, and is secreted by the membranes of the arms. It is now quite certain that such shells as those of the fossil *ammonites* and *orthocerata*. would be incompatible with *dibranchiate* organization.

† "The complex, irritable mechanism, of all these suckers, is under the complete control of the animal. Mr. Broderip informs me that he has attempted, with a hand-net, to catch an *octopus* that was floating by, with its long and flexible arms entwined round a fish, which it was tearing with its sharp hawk's bill; it allowed the net to approach within a short distance before it relinquished its prey, when, in an instant, it relaxed its thousand suckers, exploded its inky ammunition, and rapidly retreated under cover of the cloud which it had occasioned, by rapid and vigorous strokes of its circular web." (*Owen.*)

‡ Indian ink and sepia are now made of lamp-smoke, or of prepared charcoal.

The skin of the naked cephalopods is remarkable for its variously coloured vesicles, or pigment-cells. In *sepia* they are black and brown; in the calamary, yellow, red, and brown; and in the argonaut, and some octopods, there are blue cells besides. These cells alternately contract and expand, by which the colouring matter is condensed or dispersed, or perhaps driven into the deeper part of the skin. The colour accumulates, like a blush, when the skin is irritated, even several hours after separation from the body. During life, these changes are under the control of the animal, and give it the power of changing its hue, like the chameleon. In fresh specimens, the *sclerotic plates* of the eyes have a pearly lustre; they are sometimes preserved in a fossil state.

The *aquiferous pores* are situated on the back and sides of the head, on the arms (*brachial*), or at their bases (*buccal pores*).

The *mantle* is usually connected with the back of the head by a broad ("*nuchal*") muscular band; but its margin is sometimes free all round, and it is supported only by cartilaginous ridges, fitting into corresponding grooves,* and allowing considerable freedom of motion.

The cuttle-fishes are nocturnal, or crepuscular animals, concealing themselves during the day, or retiring to a lower region of the water. They inhabit every zone, and are met with equally near the shore, and in the open sea, hundreds of miles from land. They attain occasionally a much greater size than any other mollusca. MM. Quoy and Gaimard found a dead cuttle-fish in the Atlantic, under the equator, which must have weighed 2 cwt. when perfect; it was floating on the surface, and was partly devoured by birds. Banks and Solander, also met with one under similar circumstances, in the Pacific, which was estimated to have measured six feet in length. (*Owen.*) The arms of the octopods are sometimes two feet long.† From their habits, it is difficult to capture some species alive, but they are frequently obtained, uninjured, from the stomachs of dolphins, and other fishes which prey upon them.

SECTION A. Octopoda.

Arms 8; suckers sessile. *Eyes* fixed, incapable of rotation. *Body* united to the head by a broad cervical band. *Branchial chamber* divided longitudinally by a muscular partition. *Oviduct* double; no distinct nidamental gland. *Shell* external and one-celled (*mono-thalamous*), or internal and rudimentary.

The Octopods differ from the typical cuttle-fishes in having only eight arms, without the addition of tentacles; their bodies are round, and they seldom have fins. They are the most eccentric or "aberrant" mollusks, superior in organization to all the rest, but manifesting some remarkable and unexpected analogies with the lowest classes of animals.

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* Termed the "apparatus of resistance," by D'Orbigny.

† *Denys Montfort*, having represented a "kraken octopod," in the act of scuttling a three-master, told M. Defrance, that if this were "swallowed," he would in his next edition represent the monster embracing the Straits of Gibraltar, or capsizing a whole squadron of ships. (*D'Orbigny.*)

The males of some species of *octopus* and *eledone,* are similar to the females, but are comparatively scarce. Only the females of many others are known, and every specimen of the argonaut hitherto examined (amounting to many hundreds), has been of that sex. Dr. Albert Kölliker has suggested that the real males of the argonaut, and also of *octopus granulatus* and *tremoctopus violaceus* are the *hectocotyles,* previously mistaken for *parasitic worms.*

The *hectocotyle* of *octopus granulatus* was described by Cuvier,* who obtained several specimens from octopods captured in the Mediterranean. It is five inches in length, and resembles a detached arm of the octopus, its under surface being bordered with 40 or 50 pairs of alternate suckers.

The *hectocotyle* of *tremoctopus* was discovered by Dr. Kölliker, at Messina, in 1842, adhering to the interior of the gill-chamber and funnel of the poulpe; it is represented in Pl. I., fig. 3. The body is worm-like, with two rows of suckers on the ventral surface, and an oval appendage at the posterior end. The anterior part of the back is fringed with a double series of branchial filaments (250 on each side). Between the branchiæ are two rows of brown or violet *spots,* like the pigment cells of the *tremoctopus.* The suckers (40 on each side) closely resemble those of the *tremoctopus,* in miniature. Between the suckers are four or five series of *pores,* the openings of minute canals, passing into the abdominal cavity. The *mouth* is at the anterior extremity, and is minute and simple; the alimentary canal runs straight through the body, nearly filling it. The *heart* is in the middle of the back, between the branchiæ; it consists of an auricle and a ventricle, and gives origin to two large vessels. There is also an artery and vein on each side, giving branches to the branchial filaments. A *nerve* extends along the intestine, and one ganglion has been observed. The *oval sac* incloses a small but very long convoluted tube, ending in a muscular *vas deferens;* it contains innumerable *spermatozoa.*

The *hectocotyle* of the argonaut was discovered by *Chiaje,* who considered it a parasitic worm, and described it under the name of *trichocephalus acetabularis;* it was again described by *Costa,*† who regarded it as "a spermatophore of singular shape;" and lastly by Dr. Kölliker.‡

It is similar in form to the others, but is only seven lines in length, and has a filiform appendage in front, six lines long. It has two rows of alternate

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* An. Sc. Nat. 1 Series, t. 18. p. 147. 1829.

† An. Sc. Nat. 2 Series, 7. p. 173.

‡ Lin. Trans. Vol. 20, pt. 1, p. 9; and in his own zootomical *berichte,* where it is figured.

suckers, 45 on each side; but no *branchiæ*; the skin contains numerous changeable spots of red or violet, like that of the argonaut.*

According to the observations of Madame Power, "the newly hatched *argonaut* has no shell, and is quite unlike what it afterwards becomes; it is a sort of little worm, having two rows of suckers along its length, with a filiform appendage at one extremity, and a small swelling at the other. It might be supposed to represent an *extremely small brachial appendage,* from which the other parts were afterwards to be developed."† (*Kölliker.*)

FAMILY I. ARGONAUTIDÆ.

Dorsal arms (of the female) webbed at the extremity, secreting a symmetrical involuted shell. *Mantle* supported in front by a single ridge on the funnel.

Genus ARGONAUTA, Lin. Argonaut or paper sailor.

Etymology, *argonautai,* sailors of the ship Argo.

Synonyms, ocythoë (Rafinesque). Nautilus (Aristotle and Pliny).

Example, A. hians, Soland, pl. II., fig. 1. China.

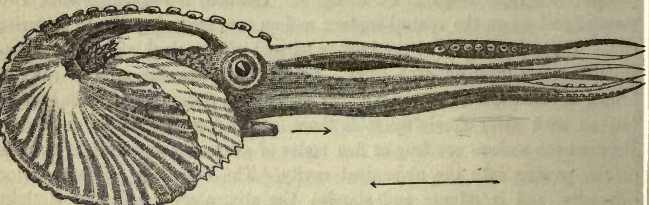

Fig. 32. *Argonauta argo L. swimming.*‡

The *shell* of the argonaut is thin and translucent; it is not moulded on the body of the animal, nor is it attached by shell-muscles; and the unoccupied hollow of the spire serves as a receptacle for the minute clustered eggs. The argonaut sits in its boat with its siphon turned towards the keel,§ and its sail-shaped (dorsal) arms closely applied to the sides of the shell, as in fig. 32, where, however, they are represented as partially withdrawn, in order to show the margin of the aperture. It swims only by ejecting water from its fun-

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[*] Similar instances of a permanently rudimentary condition of the male sex, occur amongst the lowest organized parasitic crustaceans; the males of *achtheres, lernæopoda, tracheliaster, &c.,* are frequently a thousand times smaller than the female, upon whom they live, and from whom they differ both in form and structure. Mr Gosse has described a similar disparity of the sexes in *asplanchna.*

[†] An. Sc. Nat. 2 Series, vol. 16, p. 185.

[‡] From a copy of Rang's figure, in Charlesworth's Magazine; one-fourth the natural size; the small arrow indicates the current from the *funnel,* the large arrow the direction in which the "sailor" is driven by the recoil.

[§] Poli has represented it sitting the opposite way; the writer had once an argonaut shell with the nucleus *reversed,* implying that the animal had *turned quite round* in its shell, and remained in that position. The specimen is now in the York Museum.

nel, and crawls in a reversed position, carrying its shell over its back like a snail. (*Madame Power and M. Rang.*)

It was the *nautilus* (*primus*) of Aristotle, who described it as floating on the surface of the sea, in fine weather, and holding out its sail-shaped arms to the breeze; a pretty fable, which poets have repeated ever since.

Distribution: 4 species of argonaut are known; they inhabit the open sea throughout the warmer parts of the world. Captain King took several from the stomach of a dolphin, caught upwards of 600 leagues from any land.

Fossil: A. hians is found in the sub-apennine tertiaries of Piedmont. This species is still living in the Chinese seas, but not in the Mediterranean.

FAMILY II. OCTOPODIDÆ.

Arms similar, elongated, united at the base by a web. *Shell* represented by two short styles, encysted in the substance of the mantle. (*Owen.*)

OCTOPUS, Cuvier. Poulpe.

Etym., *octo*, eight, *pous* (*poda*) feet.

Syn., *cistopus*. (*Gray.*)

Ex., O. tuberculatus Bl., pl. I., figs. 1 and 2 (mandibles).

Body oval, warty or cirrose, without fins; *arms* long, unequal; *suckers* in two rows; *mantle* supported in front by the branchial septum.

The octopods are the "polypi" of Homer and Aristotle; they are solitary animals, frequenting rocky shores, and are very active and voracious; the females oviposit on sea-weeds, or in the cavities of empty shells. In the markets of Smyrna and Naples, and the bazaars of India, they are regularly exposed for sale. "Although common (at St. Jago) in the pools of water left by the retiring tide, they are not very easily caught. By means of their long arms and suckers they can drag their bodies into very narrow crevices, and when thus fixed it requires great force to remove them. At other times they dart tail first, with the rapidity of an arrow, from one side of the pool to the other, at the same instant discolouring the water with a dark chesnut-brown ink. They also escape detection by varying their tints, according to the nature of the ground over which they pass. In the dark they are slightly phosphorescent." (*Darwin.*)*

Professor E. Forbes has observed that the octopus, when resting, coils its dorsal arms over its back, and seems to shadow forth the argonaut's shell.

Distr., universally found on the coasts of the temperate and tropical zones; 46 species are known; when adult they vary in length from 1 inch to 2 feet, according to the species.

PINNOCTOPUS, D'Orb. Finned octopus.

Body with lateral fins, united behind.

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* Journal of a Voyage round the World. The most fascinating volume of travels published since Defoe's fiction.

The only known species, *P. cordiformis*, was discovered by MM. Quoy and Gaimard, on the coast of New Zealand; it exceeds 3 feet in length.

ELEDONE. (Aristotle.) Leach.

Type, E. octopodia, L.

Suckers forming a single series on each arm; length 6 to 18 inches. *E. moschata* emits a musky smell.

Distr., 2 sp. Coasts of Norway, Britain, and the Mediterranean.

CIRROTEUTHIS, Eschricht. 1836.

Etym., *cirrus*, a filament, and *teuthis* a cuttle-fish.

Body with two transverse fins; *arms* united by a web, nearly to their tips; *suckers* in a single row, alternating with *cirri*. Length 10 inches. Colour violet. The only species (*C. Mülleri Esch.*) inhabits the coast of Greenland.

PHILONEXIS, D'Orb.

Etym., *philos*, an adept in *nexis*, swimming.

Type, P. atlanticus, D'Orb.

Arms free; suckers in two rows; *mantle* supported by two ridges on the funnel. Total length, 1 to 3 inches.

Distr., 6 sp. Atlantic and Medit. Gregarious in the open sea; feeding on floating *mollusca.*

Sub-genus. Tremoctopus (Chiaje), pl. I., fig. 3.

Name from two large aquiferous pores (*tremata*) on the back of the head.

Arms partly, or all webbed half-way up.

Distr., 2 sp. T. quoyanus and violaceus. Atlantic and Medit.

SECTION B. DECAPODA.

Arms 8. *Tentacles* 2, elongated, cylindrical, with expanded ends. *Suckers* pedunculated, armed with a horny ring. *Mouth* surrounded by a buccal membrane, sometimes lobed and funished with suckers. *Eyes* moveable in their orbits. *Body* oblong or elongated, always provided with a pair of fins. *Funnel* usually furnished with an internal valve. *Oviduct* single. *Nidamental gland* largely developed. *Shell* internal; lodged loosely in the middle of the dorsal aspect of the mantle.

The arms of the decapods are comparatively shorter than those of the octopods; the dorsal pair is usually shortest, the ventral longest. The tentacles originate within the circle of the arms, between the third and fourth pairs; they are usually much longer than the arms, and in *cheiroteuthis* are six times as long as the animal itself. They are completely retractile into large subocular pouches in *sepia*, *sepiola*, and *rossia;* partly retractile in *loligo* and *sepioteuthis;* non-retractile in *cheiroteuthis*. They serve to seize prey which may be beyond the reach of the ordinary arms, or to moor the animal in safety during the agitation of a stormy sea.

The *shell* of the living decapods is either a horny "pen" (*gladius*) or a calcarious "bone" (*sepion*); not attached to the animal by muscles, but so loose as to fall out when the cyst which contains it is opened. In the genus *spirula*, it is a delicate spiral tube, divided into air-chambers by a series of partitions (*septa*). In the fossil genus *spirulirostra*, a similar shell forms the apex of a cuttle-bone; in the fossil *conoteuthis* a chambered shell is combined with a *pen;* and the *belemnite* unites all these modifications.

The decapods chiefly frequent the open sea, appearing periodically like fishes, in great shoals, on the coasts and banks. (*Owen*, *D'Orb.*)

FAMILY III. TEUTHIDÆ. Calamaries, or Squids.

Body, elongated; *fins* short, broad, and mostly terminal.

Shell, (gladius or *pen*) horny, consisting of three parts,—a shaft, and two lateral expansions or wings.

Sub-family A. *Myopsidæ*, D'Orb. *Eyes* covered by the skin.

Loligo. (*Pliny*) Lamarck. Calamary.

Syn., *teuthis* (Aristotle) Gray.

Type, L. vulgaris (sepia loligo L.) Fig. 1. Pl. I., fig. 6 (pen).

Pen, lanceolate, with the shaft produced in front; it is multiplied by age, several being found packed closely, one behind another, in old specimens. (Owen.)

Body tapering behind, much elongated in the males. *Fins* terminal, united, rhombic. *Mantle* supported by a cervical ridge, and by two grooves in the base of the funnel. *Suckers* in two rows, with horny, dentated hoops. *Tentacular club* with four rows of suckers. Length (excluding tentacles) from 3 inches to 2½ feet.

The calamaries are good swimmers; they also crawl, head-downwards, on their oral disk. The common species is used for bait, by fishermen, on the Cornish coast (Couch). Shells have been found in its stomach, and more rarely sea-weed (Dr. Johnston). Their egg-clusters have been estimated to contain nearly 40,000 eggs (Bohadsch).

Distr., 21 sp. in all seas. Norway—New Zealand.

Sub-genus. *Teudopsis*, Deslongchamps, 1835.

Etym., *teuthis*, a calamary and *opsis* like.

Type, T. Bunellii, Desl.

Pen, like *loligo*, but dilated and spatulate behind.

Fossil, 5 sp. Upper Lias, France, and Wurtemberg.

Gonatus, Gray.

Animal and *pen* like *loligo* in most respects. *Arms* with 4 series of cups, *tentacular club* with numerous small cups, and a single large sessile cup armed with a hook; funnel valveless.

Distr., a single species (*G. amœna*, Moller sp.) is found on the coast o Greenland.

Sepioteuthis, Blainville.

Type, S. sepioïdea, Bl. *Animal* like *loligo; fins* lateral, as long as th body. Length from 4 inches to 3 feet.

Distr., 13 sp., West Indies, Cape, Red Sea, Java, Australia.

Beloteuthis, Münster.

Etym., *belos,* a dart and *teuthis.*

Type, B. subcostata, Münst. Pl. II., fig. 8., U. Lias, Wurtemberg.

Pen, horny, lanceolate; with a very broad shaft, pointed at each end and small lateral wings.

Distr., 6 sp. described by Münster, considered varieties (differing in ag and sex), by M. D'Orbigny.

Geoteuthis, Münster.

Etym., *ge,* the earth (*i. e.* fossil) and *teuthis.*

Syn., belemnosepia (Agassiz.) belopeltis (Voltz) loligosepia (Quenstedt.)[*]

Pen broad, pointed behind; shaft broad, truncated in front; lateral wing shorter than the shaft.

Fossil, 9 sp. U. Lias, Wurtemberg; Calvados; Lyme Regis. Severa undescribed sp. in the Oxf. clay, Chippenham.

Besides the *pens* of this calamary the *ink-bag*, the muscular mantle, an the bases of the arms, are preserved in the Oxford clay. Some of the ink-bags found in the Lias are nearly a foot in length, and are invested with brilliant nacreous layer; the ink forms excellent *sepia.* It is difficult to understand how these were preserved, as the recent calamaries "spill their ink" on the slightest alarm. (*Buckland*).

Leptoteuthis, Meyer.

Etym., *Leptos* thin, and *teuthis.*

Type, L. gigas Meyer, Oxford clay, Solenhofen.

Pen very broad and rounded in front, pointed behind; with obscure diverging ribs.

Cranchia, Leach, 1817.

Named in honour of Mr. J. Cranch, naturalist to the Congo expedition.

Type, C. scabra, Leach.

Body large, ventricose; fins small, terminal; mantle supported in fron by a branchial septum. Length 2 inches. *Head* very small. *Eyes* fixed *Buccal* membrane large, 8-lobed. *Arms* short, suckers in two rows. *Tentacular* clubs finned behind, cups in 4 rows. *Funnel* valved.

Pen long and narrow.

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[*] These names must be set aside, being incorrect in themselves, and founded o a total misapprehension of the nature of the fossils.

Distr., 2 sp. W. Africa. In the open sea.

This genus makes the nearest approach to the octopods.

SEPIOLA. (Rondelet) Leach, 1817.

Ex., S. atlantica (D'Orb.) Pl. I., fig. 4.

Body short, purse-like; mantle supported by a broad cervical band, and a ridge fitting a groove in the funnel. *Fins* dorsal, rounded, contracted at the base. *Suckers* in 2 rows, or crowded, on the arms, in 4 rows on the tentacles. Length 2 to 4 inches.

Pen, half as long as the back. *S. stenodactyla* (sepioloidea, D'Orb.) has no pen.

Distr., 6 sp. Coasts of Norway, Britain, Medit., Mauritius, Japan, Australia.

Sub-genus. Rossia, Owen (*Fidenas?* Gray). *Mantle* supported by a cervical ridge and groove. *Suckers* in 2 rows on the tentacles. Length 3 to 5 inches.

Distr., 6 sp. Regent Inlet, Britain, Medit., Manilla.

Sub-family B. *Oigopsidæ*, D'Orb.

Eyes naked. *Fins* always terminal, and united, forming a rhomb.

LOLIGOPSIS, Lam. 1811.

Etym., loligo, and *opsis*, like.

Type, L. pavo (Lesueur).

Body elongated, mantle supported in front by a branchial septum. *Arms* short. *Cups* in 2 rows. *Tentacles* slender, often mutilated. *Funnel* valveless.

Pen slender, with a minute conical appendix. Length from 6 to 12 inches.

Distr., pelagic. 8 sp. N. Sea, Atlantic, Medit., India, Japan, S. Sea.

CHEIROTEUTHIS, D'Orb.

Etym., *cheir*, the hand, and *teuthis*.

Type, C. veranii, Fér.

Mantle supported in front by ridges. *Funnel* valveless. *Ventral arms* very long. *Tentacles* extremely elongated, slender, with distant sessile cups on the peduncles, and 4 rows of pedunculated claws on their expanded ends.

Pen slender, slightly winged at each end. Length of the body 2 inches; to the tips of the arms 8 inches; to the ends of the tentacles 3 feet.

Distr., 2 sp. Atlantic, Medit. On gulf-weed, in the open sea.

HISTIOTEUTHIS, D'Orb.

Etym., *histion*, a veil; and *teuthis*.

Type, H. bonelliana, Fér. Length 16 inches.

Body short. *Fins* terminal, rounded. *Mantle* supported in front by ridges and grooves. *Buccal* membrane 6-lobed. *Arms* (except the ventral pair), webbed high up. *Tentacles* long, outside the web, with 6 rows of dentated cups on their ends.

Pen short and broad.

Distr., 2 sp. Mediterranean; in the open sea.

Onychoteuthis, Lichtenstein. Uncinated calamary.

Etym., *onyx*, a claw, and *teuthis.*

Type, O. banksii, Leach. (= bartlingii ?) Pl. I., fig. 7 and fig. 8 (*pen*)

Syn., ancistroteuthis (Gray). Onychia (Lesueur).

Pen narrow, with hollow, conical apex.

Arms with 2 rows of suckers. *Tentacles* long and powerful, armed with a double series of hooks; and usually having a small group of suckers at the base of each club, which they are supposed to unite, and thus use their tentacles in conjunction.* Length 4 inches to 2 feet.

The uncinated calamaries are solitary animals, frequenting the open sea, and especially the banks of gulf-weed (*sargasso*). O. banksii ranges from Norway to the Cape and Indian ocean; the rest are confined to warm seas. *O. dussumieri* has been taken swimming in the open sea, 200 leagues north of the Mauritius.

Distr., 6 sp. Atlantic, Indian ocean, Pacific.

Enoploteuthis, D'Orb. Armed calamary.

Etym., *enoplos,* armed, and *teuthis.*

Type, E. smithii, Leach.

Syn., ancistrochirus and abralia (Gray), octopodoteuthis (Ruppell), verani (Krohn).

Pen lanceolate. *Arms* provided wlth a double series of horny hooks, concealed by retractile webs. *Tentacles* long and feeble, with small hooks at th end. Length (excluding the tentacles) from 2 inches to 1 foot; but som species attain a larger size. In the muscum of the College of Surgeons ther is an arm of the specimen of E. unguiculata, found by Banks and Solander i Cook's first voyage (mentioned at p. 64) supposed to have been 6 feet lon when perfect. The natives of the Polynesian Islands, who dive for shell-fish have a well-founded dread of these formidable creatures. (*Owen.*)

Distr., 10 sp. Medit., Pacific.

Ommastrephes, D'Orb. Sagittated calamary.

Etym., *omma,* the eyes, and *strepho,* to turn.

Type, O. sagittatus, Lam.

Body cylindrical; terminal fins large and rhombic. *Arms* with 2 rows o suckers, and sometimes an internal membranous fringe. *Tentacles* short an strong, with 4 rows of cups.

Pen, consisting of a shaft with three diverging ribs, and a hollow conica appendix. Length from 1 inch to nearly 4 feet.

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* The obstetric forceps of Professor Simpson were suggested by the suckers of th calamary.

The sagittated calamaries are gregarious, and frequent the open sea in all climates. They are extensively used in the cod-fishery off Newfoundland, and are the principal food of the dolphins and cachalots, as well as of the albatross and larger petrels. The sailors call them "sea-arrows" or "flying squids," from their habit of leaping out of the water, often to such a height as to fall on the decks of vessels. They leave their eggs in long clusters floating at the surface.

Distr., 14 recent sp.; similar *pens* (4 sp.) have been found fossil in the Oxford clay, Solenhofen; it may, however, be doubted whether they are generically identical.

FAMILY IV. BELEMNITIDÆ.

Shell consisting of a *pen*, terminating posteriorly in a chambered cone, sometimes invested with a fibrous *guard*. The air-cells of the *phragmo-cone* are connected by a *siphuncle*, close to the ventral side.

BELEMNITES, Lamarck. 1801.

Etym., *belemnon*, a dart.*

Ex., B. puzosianus, pl. II., fig. 5.

Phragmocone horny, slightly nacreous, with a minute globular nucleus at its apex; divided internally by numerous concave *septa*. *Pen* represented by two nacreous bands on the dorsal side of the phragmocone, and produced beyond its rim, in the form of sword-shaped processes (pl. II., fig. 5).† *Guard*, fibrous, often elongated and cylindrical; becoming very thin in front, where it invests the phragmocone.‡

Nearly 100 species of belemnites have been found in a fossil state, ranging from the lias to the gault, and distributed over all Europe. The *phragmocone* of the belemnite, which represents the terminal appendix of the calamaries, is

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* The termination *ites* (from *lithos*, a stone) was formerly given to all *fossil* genera.

† The most perfect specimens known are in the cabinet of Dr. Mantell, and the British Museum; they were obtained by William Buy in the Oxford clay of Christian Malford, Wilts. The *last chamber* of a lias belemnite in the British Museum is 6 inches long, and 2½ inches across at the smaller end; a fracture near the siphuncle shows the *ink-bag*. The *phragmocone* of a specimen corresponding to this in size, measures 7½ inches in length.

‡ The specific gravity of the guard is identical with that of the shell of the recent pinna, and its structure is the same. Parkinson and others have supposed that it was originally a light and porous structure, like the cuttle-bone; but the *mucro* of the sepiostaire, with which alone it is homologous, is quite as dense as the belemnite. We are indebted to Mr. Alex. Williams, M.R.C.S., for the following specific gravities of recent and fossil shells, compared with water as 1,000:—

Belemnites puzosianus, Oxford clay	2,674
Belemnitella mucronata, chalk	2,677
Pinna, recent, from the Mediterranean	2,607
Trichites plottii, from the inferior oolite	2,670
Conus monile, recent	2,910
Conus ponderosus, Miocene, Touraine	2,713

divided into air-chambers, connected by a small tube (*siphuncle*), like the shel of the pearly nautilus. It is exceedingly delicate, and usually owes its preser tion to the infiltration of calc. spar; specimens frequently occur in the lias with the meniscus-shaped casts of the air-chambers loose, like a pile of watch-glasses. It is usually eccentric, its apex being nearest to the ventral side o the guard. The *guard* is very variable in its proportions, being sometime only half an inch longer than the phragmocone, at others one or two feet i length. These variations probably depend to some extent on age and sex M. D'Orbigny believes that the shells of the males are always (comparatively) long and slender; those of the females are at first short, but afterwards growing only at the points, they become as long in proportion as the others. Th guard always exhibits (internally) concentric lines of growth; in *B. irregulari* its apex is hollow. The belemnites have been divided into groups by the presence and position of furrows in the surface of the guard.

SECTION I. Acœli (Bronn.) without dorsal or ventral grooves.

Sub-section 1. *Acuarii*, without lateral furrows, but often channelled a the extreme point.

Type., b. acuarius. 20 sp. Lias—Neocomian.

Sub-section 2. *Clavati*, with lateral furrows.

Type, b. clavatus. 3 sp. Lias.

SECTION II. Gastrocœli (D'Orb.) Ventral groove distinct.

Sub-section 1. *Canaliculati*, no lateral furrows.

Type, b. canaliculatus. 5 sp. Inf. oolite—Gt. oolite.

Sub-section 2. *Hastati*, lateral furrows distinct.

Type, b. hastatus. 19 sp. U. lias—Gault.

SECTION III. Notocœli (D'Orb.) with a dorsal groove, and furrowed o each side.

Type, b. dilatatus. 9 sp. Neocomian.

The belemnites appear to have been gregarious, from the exceeding abundance of their remains in many localities, as in some of the marlstone quarrie of the central counties, and the lias cliffs of Dorsetshire. It is also probabl that they lived in a moderate depth of water, and preferred a muddy botto to rocks or coral-reefs, with which they would be apt to come in perilous collision. Belemnites injured in the life-time of the animal have been frequentl noticed.

Belemnitella, D'Orb.

Syn., actinocamax, Miller (founded on a mistake.)

Type, B. mucronata, Sby. Pl. II., fig. 6.

Distr., Europe; N. America. 5 sp. U. greensand and chalk.

The *guard* of the belemnitella has a straight fissure on the ventral side o its alveolar border; its surface exhibits distinct vascular impressions. Th *phragmocone* is never preserved, but casts of the alveolus show that it was chambered, that it had a single dorsal ridge, a ventral process passing into the fissure of the guard, and an apical nucleus.

ACANTHOTEUTHIS (Wagner), Münster.

Etym., *acantha*, a spine, and *teuthis*.

Syn., Kelæno (Munster.) Belemnoteuthis?

Type, A. prisca, Ruppell.

Founded on the fossil hooks of a calamary, preserved in the Oxford clay of Solenhofen. These show that the animal had 10, nearly equal arms, all furnished with a double series of horny claws, throughout their length. A *pen* like that of the *ommastrephes* has been hypothetically ascribed to these arms, which may, however, have belonged to the *belemnite* or the *belemnoteuthis*.

BELEMNOTEUTHIS (Miller), Pearce, 1842.

Type, B. antiquus (Cunnington), fig. 33.

Shell consisting of a *phragmocone*, like that of the belemnite; a horny dorsal *pen* with obscure lateral bands; and a thin fibrous *guard*, with two diverging ridges on the dorsal side.

Animal provided with *arms* and *tentacles* of nearly equal length, furnished with a double alternating series of horny hooks, from 20 to 40 pairs on each arm; *mantle* free all round; *fins* large, medio-dorsal (much larger than in fig. 33).

Fossil in the Oxford clay of Chippenham. Similar horny claws have been found in the lias of Watchett; and a *guard* equally thin is figured in Buckland's Bridgewater Treatise, t. 44, fig. 14.

In the fossil calamary of Chippenham, the shell is preserved along with the muscular mantle, fins, ink-bag, funnel, eyes, and tentacles with their horny hooks; all the specimens were discovered, and developed with unexampled skill, by William Buy, of Sutton, near Chippenham.

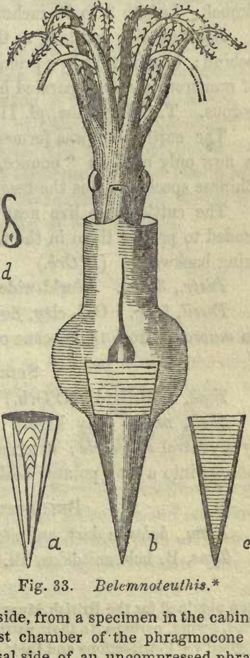

Fig. 33. *Belemnoteuthis.**

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* Fig. 33. *Belemnoteuthis antiquus*, $\frac{1}{4}$, ventral side, from a specimen in the cabinet of William Cunnington, Esq., of Devizes. The last chamber of the phragmocone is preserved in this specimen. *a*, represents the dorsal side of an uncompressed phragmocone from the Kelloway rock, in the cabinet of J. G. Lowe, Esq.; *c*, is an ideal section of the same. Since this woodcut was executed, a more complete specimen has

CONOTEUTHIS, D'Orb.

Type, C. Dupinianus, D'Orb. Pl. II., fig. 9. *Neocomian,* France.

Phragmocone slightly curved. *Pen* elongated, very slender.

This shell, which is like the pen of an ommastrephe, with a chambered cone, connects the ordinary calamaries with the belemnites.

FAMILY V. SEPIADÆ.

Shell (cuttle-bone or *sepiostaire*) calcarious; consisting of a broad laminated plate, terminating behind in a hollow, imperfectly chambered apex (*mucro*). *Animal* with elongated tentacles, expanded at their ends.

SEPIA (Pliny), Linnæus.

Type, S. officinalis, L. Pl. I., fig. 5.

Syn., *belosepia,* Voltz. (B. sepioïdea, pl. II., fig. 3, mucro only.)

Body oblong, with lateral fins as long as itself. *Arms* with 4 rows of suckers. *Mantle* supported by tubercles fitting into sockets on the neck and funnel. Length 3 to 28 inches.

Shell as wide and long as the body; very thick in front, concave internally behind; terminating in a prominent *mucro.* The thickened part is composed of numerous plates, separated by vertical fibres, which render it very light and porous. T. Orbignyana, pl. II., fig. 2.

The cuttle-bone was formerly employed as an antacid by apothecaries; it is now only used as "pounce," or in casting counterfeits. The bone of a Chinese species attains the length of 1½ feet. (*Adams.*)

The cuttle-fishes live near shore, and the *mucro* of their shell seems intended to protect them in the frequent collisions they are exposed to in swimming backwards. (*D'Orb.*)

Distr., 30 sp. World-wide.

Fossil, 5 sp. Oxf. clay, Solenhofen. Several species have been founded on *mucrones* from the Eocene of London and Paris. Pl. II., fig. 3.

SPIRULIROSTRA, D'Orb.

Type, S. Bellardii (D'Orb.) Pl. II., fig. 4. Miocene, Turin.

Shell, mucro only known; chambered internally; chambers connected by a ventral *siphuncle;* external spathose layer produced beyond the *phragmocone* into a long pointed beak.

BELOPTERA (Blainville) Deshayes.

Etym., belos, a dart, and *pteron,* a wing.

Type, B. belemnitoïdes, Bl. Pl. II., fig. 7.

been obtained for the British Museum; the *tentacles* are not longer than the ordinary arms, owing, perhaps, to their partial retraction; this specimen will be figured in Dr Mantell's "Petrifactions and their Teachings." *d,* is a single hook, natural size; the specimens belonging to Mr. Cunnington and the late Mr. C. Pearce, show the large acetabular bases of the hooks.

Shell, mucro (only known) chambered and siphuncled; winged externally.
Fossil, 2 sp. *Eocene.* Paris; Bracklesham

BELEMNOSIS, Edwards.

Type, B. anomalus, Sby. sp. Eocene. Highgate (unique.)

Shell, mucro, chambered and siphuncled; without lateral wings or elongated beak.

FAMILY VI. SPIRULIDÆ.

Shell entirely nacreous; discoidal; whirls separate, chambered (*polythalamous,*) with a ventral siphuncle.

SPIRULA, Lam., 1801.

Syn., lituus, Gray.

Ex., S. lævis (Gray.) Pl. I., fig. 9.

Body oblong, with minute terminal fins. *Mantle* supported by a cervical and 2 ventral ridges and grooves. *Arms* with 6 rows of very minute cups *Tentacles* elongated. *Funnel* valved.

Shell placed vertically in the posterior part of the body, with the involute spire towards the ventral side. The last chamber is not larger in proportion than the rest; its margin is organically connected; it contains the ink-bag.

The delicate shell of the spirula is scattered by thousands on the shores of New Zealand; it abounds on the Atlantic coasts, and a few specimens are yearly brought by the Gulf-stream, and strewed upon the shores of Devon and Cornwall. But the animal is only known by a few fragments, and one perfect specimen, obtained by Mr. Percy Earl on the coast of New Zealand.

Distr., 3 sp. All the warmer seas.

ORDER II. TETRABRANCHIATA.

Animal creeping; protected by an external shell.

Head retractile within the mantle. *Eyes* pedunculated. *Mandibles* calcarious. *Arms* very numerous. *Body* attached to the shell by adductor muscles, and by a continuous horny girdle. *Branchiæ* four. *Funnel* formed by the folding of a muscular lobe.

Shell external, camerated (poly-thalamous) and siphuncled; the inner layers and septa nacreous; outer layers porcellanous.*

It was long ago remarked by Dillwynn, that shells of the carnivorous gasteropods were almost, or altogether, wanting in the palæozoic and secondary strata; and that the office of these animals appeared to have been performed, in the ancient seas, by an order of cephalopods, now nearly extinct. Above 1,400 fossil species belonging to this order are now known by their shells; whilst their only living representative is the *nautilus pompilius*, of which several specimens have been brought to Europe within the last few years.*

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* The Chinese carve a variety of patterns in the outer opaque layer of the nautilus shell, relieved by the pearly ground beneath.

The shell of the tetrabranchiate cephalopods is an extremely elongated cone, and is either straight, or variously folded, or coiled.

It is *straight* in	orthoceras .	baculites.
bent on itself in	ascoceras .	ptychoceras.
curved in	cyrtoceras .	toxoceras.
spiral in	trochoceras .	turrilites.
discoidal in	gyroceras .	crioceras.
discoidal and produced in .	lituites . .	ancyloceras.
involute in	nautilus . .	ammonites.

Internally, the shell is divided into cells or chambers, by a series of partitions (*septa*), connected by a tube or *siphuncle.* The last chamber is occupied by the animal, the rest are empty during life, but in fossil specimens they are often filled with spar. When the outer shell is removed (as often happens to fossils,) the edges of the *septa* are seen (as in Pl. III., figs. 1, 2.) Sometimes they form curved lines, as in *nautilus* and *orthoceras,* or they are *zig-zag,* as in *goniatites* (fig. 53,) or *foliaceous,* as in the ammonite, fig. 34.

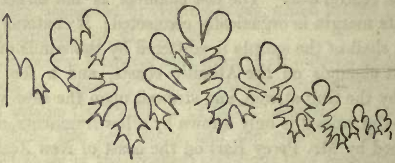

Fig. 34. *Suture of an ammonite.*†

The outlines of the *septa* are termed *sutures ;*‡ when they are folded the elevations are called *saddles,* and the intervening depressions *lobes.* In *ceratites* (fig. 54) the *saddles* are round, the lobes *dentated;* in *ammonites* both lobes and saddles are extremely complicated. Broken fossils show that the *septa* are nearly flat in the middle, and folded round the edge (like a shirt-frill), where they abut against the outer shell-wall (fig. 37).

The *siphuncle* of the recent *nautilus* is a membranous tube, with a very thin nacreous investment ; in most of the fossils it consists of a succession of funnel shaped, or bead-like tubes. In some of the oldest fossil genera, *actinoceras, gyroceras,* and *phragmoceras,* the siphuncle is large, and contains in its centre a smaller tube, the space between the two being filled up with radiating plates, like the lamellæ of a coral. The position of the siphuncle is very variable; in the *ammonitidæ* it is *external*, or close to the outer margin of the shell (fig. 37). In the *nautilidæ* it is usually *central* (fig. 35), or *internal* (fig. 36).

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* The *frontispiece,* copied from Professor Owen's Memoir, represents the animal of the first nautilus, captured off the New Hebrides, and brought to England by Mr. Bennett; it is drawn as if lying in the section of a shell, without concealing any part of it. The woodcut, fig. 43, is taken from a more perfect specimen, lately acquired by the British Museum, in which the relation of the animal to its shell is accurately shown.

† *A. heterophyllus,* Sby., from the lias, Lyme Regis. British Museum. Only one side is represented ; the arrow indicates the dorsal saddle.

‡ From their resemblance to the sutures of the skull.

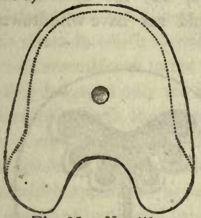

Fig. 35. *Nautilus.*

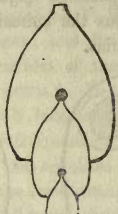

Fig. 36. *Clymenia.*

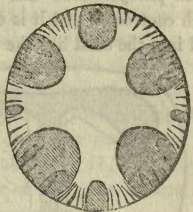

Fig. 37. *Hamites.**

The *air-chambers* of the recent nautilus are lined by a very thin, living membrane; those of the fossil *orthocerata* retain indications of a thick vascular lining, connected with the animal by spaces between the beads of the siphuncle.†

The *body-chamber* is always very capacious; in the recent nautilus its cavity is twice as large as the whole series of air-cells; in the *goniatite* (fig. 39), it occupies a whole whirl, and has a considerable lateral extension; and in *ammonites communis* it occupies more than a whirl.

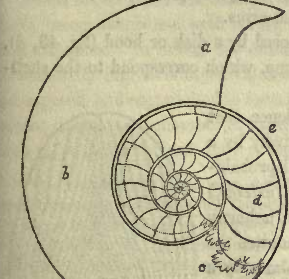

Fig. 38. *Ammonites.*

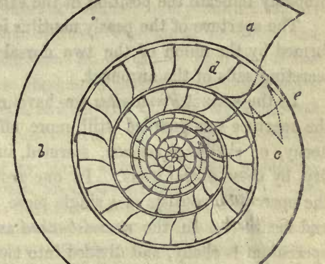

Fig. 39. *Goniatites.*‡

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* Fig. 35. Nautilus pompilius, L. Fig. 36. Clymenia striata, Münst., see pl. II., fig. 16. Fig. 37. Hamites cylindraceus Defr., see fig. 58.

† The apocryphal genus *spongarium*, was founded on detached septa of an *orthoceras*, from the Upper Ludlow rock, in which the vascular markings distinctly radiate from the siphuncle. Mr. Jones, warden of Clun Hospital, has several of these in apposition.

‡ Fig. 38. Section of *ammonites obtusus*, Sby. lias, Lyme Regis; from a very young specimen. Fig. 39. Section of *goniatites sphæricus*, Sby. carb. limestone, Bolland (in the cabinet of Mr. Tennant.) The dotted lines indicate the *lateral extent* of the body-chamber.

The *margin of the aperture* is quite simple in the recent nautilus, and affords no clue to the many curious modifications observable in the fossil forms. In the *ammonites* we frequently find a dorsal process, or lateral projections, developed periodically, or only in the adult (fig. 55, and pl. III., fig. 5).

In *phragmoceras* and *gomphoceras* (figs. 40, 41) the aperture is so much contracted that it is obvious the animal could not have withdrawn its head into the shell like the nautilus.

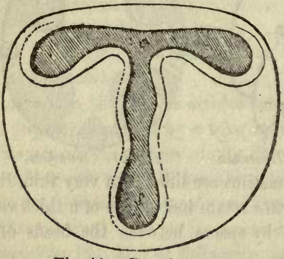

Fig. 40. *Gomphoceras.*

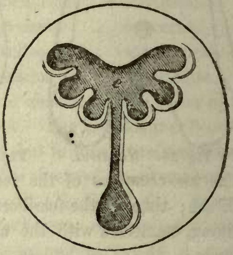

Fig. 41. *Phragmoceras.**

M. Barrande, from whose great work on the Silurian Formations of Bohemia these figures are taken, suggests that the lower part of the aperture (*s s*) which is almost isolated, may have served for the passage of the funnel, whilst the upper and larger space (*c c*) was occupied by the neck; the lobes probably indicate the position of the external arms.

The aperture of the pearly nautilus is closed by a disk or hood (fig. 43, *h*), formed by the union of the two dorsal arms, which correspond to the shell-secreting sails of the argonaut.

In the extinct *ammonites* we have evidence that the aperture was guarded still more effectively by a horny, or shelly *operculum*, secreted, in all probability, by these dorsal arms. In one group (*arietes*,) the operculum consists of a single piece, and is horny and flexible.† In the *round-backed* ammonites the operculum is shelly, and divided into two plates by a straight median suture (fig. 42). They were described in 1811, by Parkinson, who called them *trigonellites*, and pointed out the resemblance of their

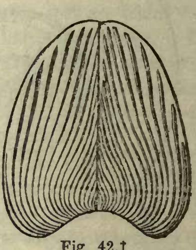

Fig. 42.‡

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* Fig. 40. *Gomphoceras Bohemicum* (Barrande), reduced view of the aperture; *s*, the siphonal opening. Fig. 41. *phragmoceras callistoma* (Barr.) both from the U. Silurian, Bohemia.

† This form was discovered by the late Miss Mary Anning, the indefatigable collector of the lias fossils of Lyme Regis, and described by Mr. Strickland, Geol. Journal, vol. I., p. 232. Also by M. Voltz, Mem. de l'Institute, 1837, p. 48.

‡ *Trigonellites lamellosus*, Park. Oxford clay, Solenhofen (and Chippenham,) associated with ammonites lingulatus, Quenstedt. (= A. Brightii, Pratt). From a specimen in the cabinet of Charles Stokes, Esq.

internal structure to the cancellated tissue of bones. Their external surface is smooth or sculptured; the inner side is marked by lines of growth. Forty-five kinds are enumerated by Bronn; they occur in all the strata in which ammonites are found, and a single specimen has been figured by M. D'Archiac, from the Devonian rocks of the Eifel, where it was associated with *goniatites*.*

Calcarious mandibles or *rhyncholites* (F. Biguet) have been obtained from all the strata in which *nautili* occur; and from their rarity, their large size and close resemblance to the mandibles of the recent nautilus, it is probable that they belonged only to that genus.† In the Muschelkalk of Bavaria one nautilus (*N. arietis,* Reinecke, = N. bidorsatus, Schlotheim,) is found, and two kinds of *rhyncholite;* one sort, corresponding with the upper mandible of the recent nautilus, has been called "rhyncholites hirundo" (pl. II., fig. 11), the other, which appears to be only the lower mandible of the same species, has been described under the name of "conchorhynchus avirostris."‡

In studying the fossil *tetrabranchiata,* it is necessary to take into consideration the varying circumstances under which they have been preserved. In some strata (as the lias of Watchett) the outer layer of the shell has disappeared, whilst the inner nacreous layer is preserved. More frequently only the outer layer remains; and in the chalk formation the whole shell has perished. In the calcarious grit of Berkshire and Wiltshire the ammonites have lost their shells; but perfect casts of the chambers, formed of calcarious spar, remain.§

Fossil *orthocerata* and *ammonites* are evidently in many instances *dead shells,* being overgrown with corals, serpulæ, or oysters; every cabinet affords such examples. In others the animal has apparently occupied its shell, and prevented the ingress of mud, which has hardened all around it; after this it has decomposed, and contributed to form those phosphates and sulphurets commonly present in the body-chamber of fossil shells, and by which the sediment around them is so often formed into a hard concretion.‖ In this state they are permeated by mineral water, which slowly deposits calcarious spar, in crystals, on their walls; or by acidulous water, which removes every trace of the shell, leaving a cavity, which at some future time may again become filled with spar, having the form of the shell, but not its structure. In some sections of *orthocerata*, it is evident that the mud has gained access to the air-cells, along the course of the blood-vessels; but the chambers are not entirely filled, because their lining membrane has contracted, leaving a space between itself and certain portions of the walls, which correspond in each chamber.

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* The *trigonellites* have been described by Meyer as bivalve shells, under the generic name of *aptychus;* by Deslongchamps under the name of *Munsteria.* M. D'Orbigny regards them as cirripedes! M. Deshayes believes them to be *gizzards* of the ammonites. M. Coquand compares them with *teudopsis;* an analogy evidently suggested by some of the membranous and elongated forms. such as *T. sanguinolarius,* found with *am. depressus,* in the lias of Boll. Ruppell, Voltz, Quenstedt, and Zieten, regard the trigonellites as the *opercula of ammonites,* an opinion also entertained by many of the most experienced fossil collectors in England.

† M. D'Orbigny has manufactured *two genera of calamaries* out of these nautilus beaks! (*rhynchoteuthis* and *palæoteuthis*). In the innumerable sections of *ammonites* which have been made, no traces of the mandibles have ever been discovered.

‡ *Lepas avirostris* (Schlotheim), described by Blainville as the beak of a brachiopod!

§ Called *spondylolites* by old writers.

‖ In the alum-shale of Whitby, innumerable *concretions* are found, which, when struck with the hammer, split open, and disclose an *ammonite.* See Dr. Mantell's "Thoughts on a Pebble," p. 21.

With respect to the purpose of the *air-chambers*, much ingenuity has been exercised in devising an explanation of their assumed *hydrostatic* function, whereby the nautilus can rise at will to the surface, or sink, on the approach of storms to the quiet recesses of the deep. Unfortunately for such poetical speculations, the nautilus appears on the surface, only *when driven up by storms*, and its sphere of action is on the *bed* of the sea, where it creeps like a snail, or perhaps lies in wait for unwary crabs and shell-fish, like some gigantic "sea-anemone," with outspread tentacles.

The tetrabranchs could undoubtedly swim, by their respiratory jets; but the discoidal nautili and ammonites are not well calculated, by their forms, for swimming; and the straight-shelled *orthocerata* and *baculites* must have held a nearly vertical position, head-downwards, on account of the buoyancy of their shells. The use of the air-chambers, is to render the whole animal (and shell) of nearly the same specific gravity with the water.* The object of the numerous partitions is not so much to sustain the pressure of the water, as to guard against the *collisions* to which the shell is exposed. They are most complicated in the *ammonites*, whose general form possesses least strength.† The purpose of the siphuncle (as suggested by Mr. Searles Wood) is to maintain the *vitality* of the shell, during the long life which these animals certainly enjoyed. Mr. Forbes has suggested that the inner courses of the *hamites*, broke off, as the outer ones were formed. But this was not the case with the *orthocerata*, whose long straight shells were particularly exposed to danger; in these the preservation of the shell was provided for by the increased size and strength of the siphuncle, and its increased vascularity. In *endoceras* we find the siphuncle thickened by *internal* deposits, until (in some of the very cylindrical species) it forms an almost solid axis.

The *nucleus* of the shell is rather large in the *nautili*, and causes an opening to remain through the shell, until the *umbilicus* is filled up with a callous deposit; several fossil species have always a hole through the centre.

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* A *nautilus pompilius* (in the cabinet of Mr. Morris) weighs 1lb., and when the siphuncle is secured, it floats with a ½lb weight in its aperture. The animal would have displaced 2 pints (= 2½lbs) of water, and therefore, if it weighed 3lbs., the specific gravity of the animal and shell would scarcely exceed that of salt water.

† The siphuncle and lobed septa did not hold the animal in its shell, as Von Buch imagined: that was secured by the shell-muscles. The complicated sutures perhaps indicate lobed ovaries; they occur in genera, which must have produced very small eggs.

In the *ammonites*, the *nucleus* is exceedingly small, and the whirls compact from the first.

It has been stated that the *septa* are formed periodically; but it must not be supposed that the shell-muscles ever become detached, or that the animal moves the distance of a chamber all at once. It is most likely that the *adductors* grow only in front, and that a constant waste takes place behind, so that they are always moving onward, except when a new septum is to be formed; the *septa* indicate periodic *rests*.

The consideration of this fact, that the nautilus must so frequently have an air-cavity between it and its shell, is alone sufficient to convince us, that the chambered cephalopods could not exist in very deep water. They were probably limited to a depth of 20 or 30 fathoms at the utmost.*

It is certain that the sexes were distinct in the *tetrabranchiata*, but since only the female of the living nautilus is known, we are left to conjecture how ar the differences observable in the shells, are dependant on sex. M. D'Orbigny, having noticed that there are two varieties of almost every kind of ammonite, —one compressed, the other inflated—naturally assumed that the first were the shells of male individuals (♂), the second of females (♀). Dr. Melville has made a similar suggestion with respect to the nautili; namely, that the umbilicated specimens are the males, the imperforated shells, females. This is rendered probable by the circumstance, that all the known specimens of *N. pompilius* were female, and that the supposed male (*N. macromphalus*) is very rare, as we have noticed amongst the male *dibranchiata*. Of the other recent species, both the presumed sexes (*N. umbilicatus* ♂ and *N. stenomphalus* ♀) are comparatively rare.

FAMILY I. NAUTILIDÆ.

Shell. *Body-chamber* capacious. *Aperture* simple. *Sutures* simple. *Siphuncle* central, or internal. (Figs. 35, 36.)

NAUTILUS, Breynius, 1732.

Shell involute or discoidal, few-whirled. *Siphuncle* central.

In the recent nautili, the shell is smooth, but in many fossil species it is corrugated, like the patent iron-roofing, so remarkable for its strength and lightness. (*Buckland.*) See pl. II., fig. 10.

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* By *deep water*, naturalists and dredgers seldom mean more than 25 fathoms, a comparatively small depth, only found near coasts and islands. At 100 fathoms the pressure exceeds 265lbs. to the square inch. Empty bottles, securely corked, and sunk with weights beyond 100 fathoms, are always crushed. If filled with liquid, the cork is driven in, and the liquid replaced by salt water; and in drawing the bottle up again, the cork is returned to the neck of the bottle, generally in a reversed position. (*Sir F. Beaufort.*)

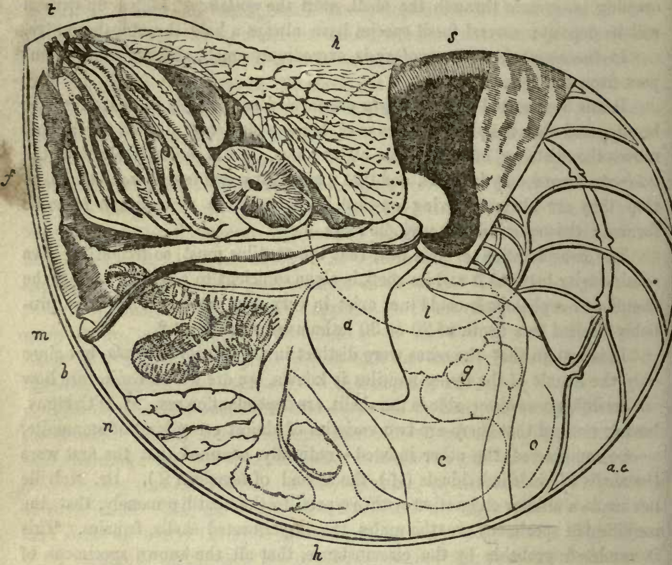

Fig. 43. *Nautilus pompilius in its shell.**

The *umbilicus* is small or obsolete in the typical nautili, and the whirls enlarge rapidly. In the palæozoic species, the whirls increase slowly, and are sometimes scarcely in contact. The last *air-cell* is frequently shallower in proportion than the rest.

Animal. In the recent nautilus, the *mandibles* are horny, but calcified to a considerable extent; they are surrounded by a circular fleshy lip, external to which are four groups of *labial tentacles,* 12 or 13 in each group, they appear to answer to the *buccal membrane* of the calamary (fig. 1). Beyond these, on each side of the head, is a double series of arms, or *brachial tentacles,* 36 in number; the dorsal pair are expanded and united to form the hood, which closes the aperture of the shell, except for a small space on each side, which is filled by the second pair of arms. The *tentacles* are lamellated on their inner surface, and are retractile within sheaths, or "digitations," which correspond to the eight ordinary arms of the cuttle-fishes; their superiority in number being indicative of a lower grade of organization. Besides these there are four *ocular tentacles*, one behind and one in front of each eye; they seem to be instruments of sensation, and resemble the tentacles of *doris* and *aplysia* (*Owen*). On the side of each eye is a hollow plicated process, which is not tentaculiferous. The *respiratory funnel* is formed by the folding of a very thick muscular lobe, which is prolonged laterally on each side of the head, with its free edge directed backwards, into the branchial cavity; behind the *hood* it is directed forwards, forming a lobe which lies against the black-stained spire of the shell (fig. 43 *s*.)* Inside the funnel is a valve-like fold (fig. 44 *s*). The margin of the mantle is entire, and extends as far as the edge of the shell; its substance is firm and muscular, as far back as the line of the shell-muscles and horny girdle, beyond which it is thin and transparent. The *shell-muscles* are united by a narrow tract, across the hollow occupied by the involute spire of the shell; and are thus rendered horse-shoe shaped. The *siphuncle* is vascular; it opens into the cavity containing the heart (*pericardium*), and is most probably filled with fluid from that cavity. (*Owen*.)

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* This woodcut and 18 others illustrating the *tetrabranchiata,* are the property of Mr. Gray, to whom we are indebted for their use. Fig. 43 represents the recent nautilus, as it appears on the removal of part of the outer shell-wall (from the specimen in the British Museum). The *eye* is seen in the centre, covered by the hood (*h*); *t,* tentacles, nearly concealed in their sheaths; *f,* funnel; *m,* margin of the mantle, very much contracted; *n,* nidamental gland; *a, c,* air-cells and siphuncle; *s,* portion of the shell; *a,* shell-muscle. The internal organs are indicated by dotted lines; *b,* branchiæ; *h,* heart and renal glands; *c,* crop; *g,* gizzard; *l,* liver; *o,* ovary.

Respecting the habits of the nautilus, very little is known, the specimen dissected by Professor Owen had it crop filled with fragments of a small crab, and its mandibles seem well adapted for breaking shells. The statement that it visits the surface of the sea of its own accord, is at present unconfirmed by observation, although the air cells would doubtless enable the animal to rise by a very small amount of muscular exertion.

Professor Owen gives the following passage, from the old Dutch naturalist, Rumphius, who wrote in 1705, an account of the rarities of Amboina. "When the nautilus floats on the water, he puts out his head and all his tentacles, and spreads them upon the water, with the poop of the shell above water; but at the bottom he creeps in the reverse position, with his boat above him, and with his head and tentacles upon the ground, making a tolerably quick progress. He keeps himself chiefly upon the ground, creeping also sometimes into the nets of the fishermen; but after a storm, as the weather becomes calm, they are seen in troops, floating on the water, *being driven up by the agitation of the waves*. This sailing, however, is not of long continuance;

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* The *funnel* is considered the homologue of the foot of the gasteropods, by Loven, a conclusion to which we cannot agree. The cephalopods ought to be compared with the *larval* gasteropods, in which the foot only serves to support an operculum;—or with the floating tribes in which the foot is obsolete, or serves only to secrete a nidamental raft (*ianthina*). However, on examining the nautilus preserved in the British Museum, and finding that the funnel was only part of a muscular collar, which extends all round the neck of the animal, we could not avoid noticing its resemblance to the siphonal lappets of *paludina*, and to that series of lappets (including the *operculigerous lobe*) which surrounds the *trochus* (fig. 87).

for having taking in all their tentacles, they upset their boat, and so return to the bottom."

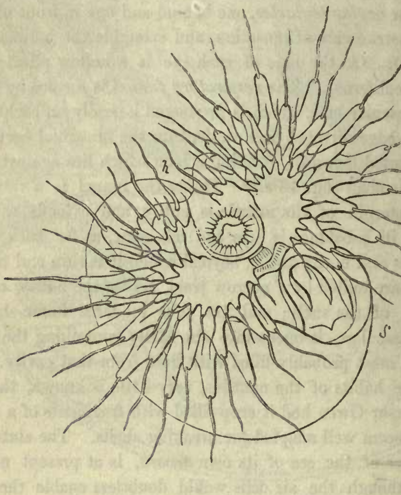

Fig. 44. *Nautilus expanded.**

Distr., 2 or 4 sp. Chinese seas, Indian ocean, Persian gulf.

Fossil, about 100 sp. In all strata, S. and N. America (Chile). Europe, India (Pondicherry).

Sub-genus. Aturia (Bronn), = Megasiphonia D'Orb.

Type, N. zic-zac Sby. Pl. II., fig. 12, London clay, Highgate.

Shell, sutures, with a deep lateral lobe; siphuncle nearly internal, large, continuous, resembling a succession of funnels.

Fossil, 4 sp. Eocene, N. America, Europe, India.

Sub-genus? Discites, McCoy. *Whirls* all exposed; the last chamber sometimes produced. L. silurian.—Carb: limestone.

Temnocheilus, McCoy. Founded on the carinated sp. of the Carb. limestone.

Cryptoceras, D'Orb. Founded on *N. dorsalis* Phil. and one other species, in which the siphuncle is nearly external.

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* Ideal representation of the nautilus, when expanded, by Professor Lovén, who appears to have taken the details from M. Valenciennes memoir in the *Archives du Museum*, vol. 2, p. 257. *h*, hood. *s*, siphon. It is just possible, that when the nautilus issues from its shell, the gas contained in the last, incomplete, air-chamber, may expand; but this could not happen under any great pressure of water.

Lituites, Breynius.

Etym., *lituus*, a trumpet.

Syn., Hortolus, Montf. (whirls separaté.) Trocholites, Conrad.

Ex., L. convolvans, Schl. L. lituus, Hisinger.

Shell, discoidal; whirls close, or separate; last chamber produced in a straight line; siphuncle central.

Fossil, 15 sp. Silurian, N. America, Europe.

Trochóceras, Barrande, 1848.

Ex., T. trochoides, Bar.

Shell, nautiloid, spiral, depressed.

Fossil, 16 sp. U. Silurian, Bohemia.

Some of the species are nearly flat, and having the last chamber produced would formerly have been considered Lituites.

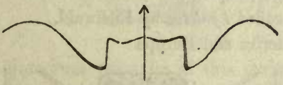

Fig. 45. *Clymenia striata, Munst.*[*]

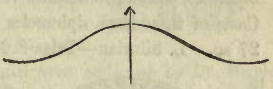

Fig. 46. *C. linearis, Munst.*

Clymenia, Munster, 1832.

Etym., clymene, a sea-nymph.

Syn. Endosiphonites, Ansted. Sub-clymenia, D'Orb.

Ex., C. striata, pl. II., fig. 16 (Mus. Tennant).

Shell, discoidal; septa simple or slightly lobed; siphuncle internal.

Fossil, 43 sp. Devonian, N. America, Europe.

FAMILY II. Orthoceratidæ.

Shell, straight, curved, or discoidal; *body chamber* small; *aperture* contracted, sometimes extremely narrow (figs. 40, 41); siphuncle complicated.

It seems probable that the cephalopods of this family were not able to withdraw themselves completely into their shells, like the pearly nautilus; this was certainly the case with some of them, as M. Barrande has stated, for the siphonal aperture is almost isolated from the cephalic opening. The shell appears to have been often less calcified, but connected with more vascular parts than in the nautilus; and the siphuncle often attains an enormous development. In all this, there is nothing to suggest a doubt of their being *tetrabranchiate;* and the chevron-shaped coloured bands preserved on the *orthoceras anguliferus,*[†] sufficiently prove that the shell was essentially external.

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[*] Fig. 45. Sutures of two species of Clymenia from Phillips' Pal. Fos., Devonshire.

[†] Figured by D'Archiac and Verneuil, Geol. Trans.

ORTHOCERAS, Breyn.

Etym., *orthos*, straight, and *ceras*, a horn.

Syn., cycloceras, McCoy. Goniocerass, Hall.*

Ex. O. giganteum (diagram of a longitudinal section), pl. II, fig. 14.

Shell, straight; siphuncle central; aperture sometimes contracted.

Fossil, 125 typical sp. (D'Orb).† L. Silurian—Trias; N. America, Australia, and Europe.

The *orthocerata* are the most abundant and wide spread shells of the old rocks, and attained a larger size than any other fossil shell. A fragment of *O. giganteum*, in the collection of Mr. Tate of Alnwick, is a yard long, and 1 foot in diameter, its original length must have been 6 feet. Other species, 2 feet in length, are only 1 inch in diameter, at the aperture.

Sub-genus I. *Cameroceras*, Conrad (= melia and thoracoceras, Fischer ?).

Siphuncle lateral, sometimes very large (*simple ?*).

Casts of these large siphuncles were called *hyolites* by Eichwald.

27 sp. L. Silurian—Trias ? N. America and Europe.

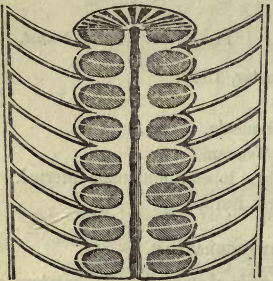

Fig. 47. *Actinoceras.*‡

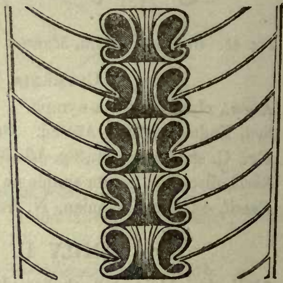

Fig. 48. *Ormoceras.*

2. *Actinoceras* (Bronn), Stokes. Siphuncle very large, inflated between the chambers, and connected with a slender central tube by radiating plates. 6 sp. L. Silurian—Carb, N. America, Baltic, and Brit.

3. *Ormoceras*, Stokes. Siphuncular beads constricted in the middle (making the septa appear as if united to the centre of each). 3 sp. L. Silurian, N. America.

4. *Huronia*, Stokes. *Shell* extremely thin, membraneous or horny ? Siphuncle very large, central, the upper part of each joint inflated, connected

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* *Theca* and *Tentaculites* are provisionally placed with the *Pteropoda*, they probably belong here.

† M Barrande has discovered 100 new species in the Upper Silurian rocks of Bohemia.

‡ Fig. 47. *Actinoceras Richardsoni*, Stokes. Lake Winipeg (diagram, reduced ½). Fig. 48. *Ormoceras, Bayfieldi*, Stokes. Drummond Island, (from Mr. Stokes' paper, Geol. Trans.)

with a small central tube by radiating plates. 3 sp. L. Silurian. Drummond Island, Lake Huron.

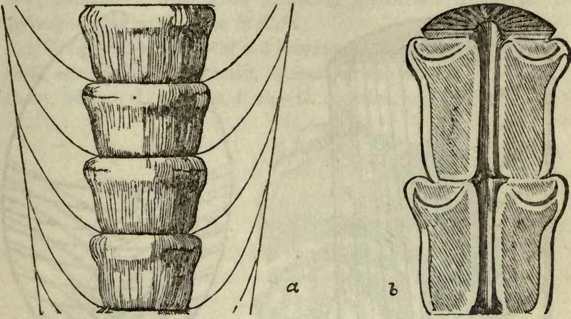

Fig. 49. *Huronia vertebralis.**

Numerous examples of this curious fossil were collected by Dr. Bigsby (in 1822), and by the officers of the regiments formerly stationed on Drummond Island. Specimens have also been brought home by the officers of many of the Artic expeditions. But with the exception of one formerly in the possession of Lieut. Gibson, 68., and another in the cabinet of Mr. Stokes, the siphuncle only is preserved, and *not a trace* remains of septa or shell wall. Some of those seen by Dr. Bigsby in the limestone cliffs, were 6 feet in length.

5. *Endoceras,* Hall (Cono-tubularia *Troost*). Shell extremely elongated, drical. Siphuncle very large, cylindrical, lateral; thickened internally by repeated layers of shell, or partitioned off by funnel-shaped diaphragms. 12 sp. Lower Silurian, New York.

6. Shell perforated by two distinct siphuncles? O. bisiphonatum Sby, Caradoc sandstone, Brit.

"Orthocerata with two siphuncles have been observed, but there has always appeared something doubtful about them. In the present instance, however, this structure cannot be questioned." (J. Sowerby.)

Small orthocerata of various species, are frequenlly found in the body chamber and open siphuncle of large specimens.† The *endoceras gemelliparum* and *proteiforme* of Hall, appear to be examples of this kind.

GOMPHOCERAS, J. Sby, 1839.

Etym., gomphos, a club, and *ceras,* a horn.

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* Fig. 49. *Huronia vertebralis,* Stokes. *a,* from a specimen in the Brit. M., presented by Dr. Bigsby. The septa are added from Dr. Bigsby's drawing; they were only indicated in the specimen by "colourless lines on the brown limestone," *b.* represents a weathered section, presented to the Brit. Mus. by Captain Kellett and Lieutenant Wood of H.M.S. Pandora. The figures are reduced ½.

† Shells of *Bellerophon* and *Murchisonia* are found under the same circumstances.

Syn., Apioceras (Fischer). Poterioceras (McCoy).

Type, G. pyriforme, Sby., fig. 51, and G. Bohemicum, Bar. fig. 40.

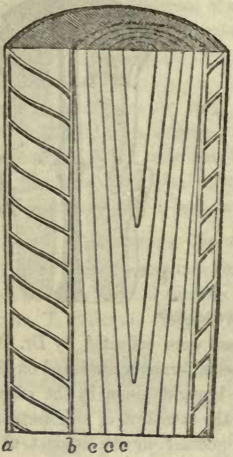

Fig. 50. *Endoceras.**

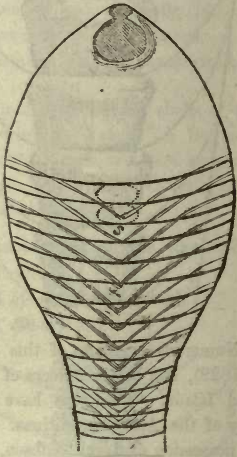

Fig. 51. *Gomphoceras.*†

Shell, fusiform or globular, with a tapering apex; aperture contracted in the middle; siphuncle moniliform, sub-central.

Distr., 10 sp. Silurian—Carb; N. America, Europe.

ONCOCERAS, Hall.

Etym., *oncos,* a protuberance.

Type, O. constrictum, Hall. Trenton limestone.

Shell, like a curved *gomphoceras*; siphuncle external.

Distr., 3 sp. Silurian, New York.

PHRAGMÓCERAS, Broderip.

Etym., *phragmos,* a partition, and *ceras,* a horn.

Type, P. ventricosum (Steininger sp.), pl. II., fig. 15.

Shell curved, laterally compressed; *aperture* contracted in the middle *siphuncle,* ventral, radiated. Ex., P. callistoma, Bar., fig. 41.

Distr., 8 sp. U. Silurian—Devonian, Brit., Germany.

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* Fig. 50. Diagram of an *endoceras* (after Hall), *a*, shell-wall. *b*. Wall of siphuncle. *c c c*. Diaphragms (" embryo-tubes " of Hall).

† Fig. 51. *Gomphoceras pyriforme.* L. Ludlow rock, Mochtre hill, Herefordshire (from Murch, Silur, syst., reduced ½). *s*. Beaded siphuncle.

Cyrtóceras, Goldf. 1833.

Etym., *curtos*, curved, *ceras*, horn.

Syn., Campulites, Desh. 1832 (including gyroceras). Aploceras, D'Orb. Campyloceras and trigonoceras, McCoy.

Ex., C. hybridum, volborthi and beaumonti (Barrande).

Shell, curved; *siphuncle* small, internal, or sub-central.

Distr., 36 sp. L. Silurian, Carb—N. America, and Europe.

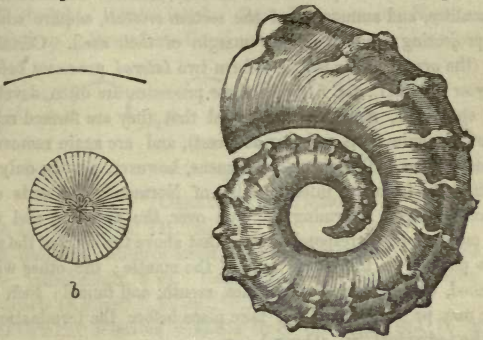

Fig. 52.*

Gyróceras, Meyer, 1829.

Etym., *gyros*, a circle, and *ceras*.

Syn., Nautiloceras, D'Orb.

Ex., G. eifeliense, D'Arch., pl. II., fig. 13. Devonian, Eifel.

Shell, nautiloid; whirls separate; siphuncle excentric, radiated.

Fossil, 17 sp. U. Silurian—Trias? N. America, and Europe.

Ascoceras, Barrande, 1848.†

Etym., *ascos*, a leather bottle.

Shell, bent upon itself, like *ptychoceras*.

Distr., 7 sp. U. Silurian, Bohemia.

FAMILY III. Ammonitidæ.

Shell. Body-chamber elongated; *aperture* guarded by processes, and closed by an operculum; *sutures* angulated, or lobed and foliated; *siphuncle* external (dorsal, as regards the shell).

The shell of the *ammonitidæ* has essentially the same structure with the nautilus. It consists of an external porcellanous‡ layer, formed by the *collar* of the mantle only; and of an internal nacreous lining, deposited by the whole extent of its visceral surface. There is an *ammonite* in the British Museum, evidently broken and repaired during the life of the animal,* which shews that the shell was deposited *from within.* In some species of ammonites the collar of the mantle forms prominent spines on the shell, which are too deep for the visceral mantle to enter; they are therefore *partitioned off* (as in *A. armatus*, Lias) from the body whirl and air cells, and not exhibited in *casts.*

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* Fig. 52. *Gyroceras goldfussii* (= ornatum Goldf). *b*. Siphuncle of *G. depressum*, Goldf. sp. Devonian. Eifel. From M.M. D'Archiac and Verneuil.

† In Haidinger's Berichte.

‡ Its microscopic structure has not been satisfactorily examined; Prof. Forbes detected a punctate structure in one species.

The baculites, and ammonites of the section *cristati,* acquire when adult a process projecting from the outer margin of their shell. Certain other ammonites (the *ornati, coronati,* &c.) form two *lateral* processes before they cease to grow (pl. III., fig. 5). As these processes are often developed in very small specimens, it has been supposed that they are formed repeatedly in the life of the animal (at each periodic rest), and are again removed when growth recommences. These small specimens, however, may be only dwarfs. In one ammonite, from the inferior oolite of Normandy, the ends of these lateral processes meet, "forming an arch over the aperture, and dividing it into two outlets, one corresponding with that above the hood of the nautilus, which gives passage to the dorsal fold of the mantle; the other with that below the hood, whence issue the tentacles, mouth, and funnel; such a modification, we may presume, could not take place before the termination of the growth of the individual."† (Owen.)

M. D'Orbigny has figured several examples of deformed *ammonites,* in which one side of the shell is scarcely developed, and the keel is consequently lateral. Such specimens probably indicate the partial atrophy of the branchiæ on one side. In the British Museum there are deformed specimens of *Am. obtusus, amaltheus, and tuberculatus.*

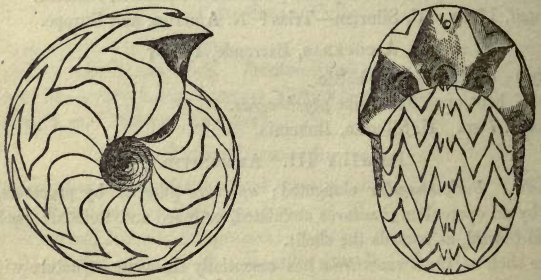

Fig. 53.‡

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* *A serpentinus* Schloth, U. Lias, Wellingboro. Rev. A. W. Griesbach.

† This unique and abnormal specimen is in the cabinet of S. P. Pratt, Esq.

‡ Fig. 53. *Goniatites sphericus,* Sby. Front and side views of a specimen from the carb limestone of Derbyshire, in the cabinet of Mr. J. Tennant; the body-chamber and shell-wall have been removed artificially.

Goniatites, De Haan.

Etym., *gonia*, angles (should be written gonialites ?).
Syn., *aganides*, Montf.
Examples, G. Henslowi, pl. III., fig. 1., G. sphericus, fig. 53, and 39.
Shell, discoidal; sutures lobed; siphuncle dorsal.
Distr. 150 sp. Devonian—Trias, Europe.

Bactrites, Sandberger (= stenoceras, D'Orb ?).

Shell, straight; sutures lobed. *Type*, B. subconicus, Sbger.
Distr., 2 sp. Devonian—Germany.

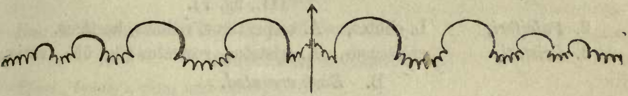

Fig. 54.*

Ceratites, De Haan.

Type, C. nodosus, pl. III., fig. 2.
Shell, discoidal; sutures lobed, the lobes crenulated. Fig. 54.
Distr., muschelkalk, 8 sp. Germany, France, Russia, Siberia.
Salt-marls (Keuper). 17 sp. S. Cassian, Tyrol.

M. D'Orbigny describes 5 shells from the gault and U. greensand as *ceratites;* but many ammonites have equally simple sutures, when young.

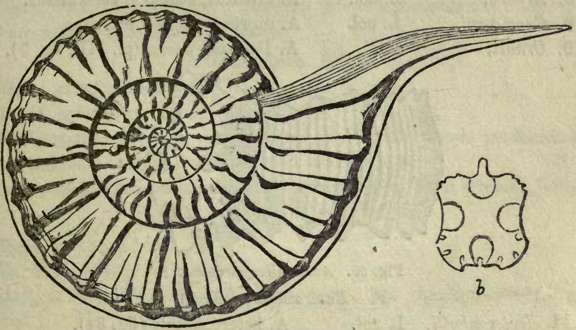

Fig. 55.†

Ammonites, Bruguiere.

Etym., *ammon*, a name of Jupiter, worshipped in Libya under the form of a ram. The ammonite is the *cornu ammonis* of old authors.

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* Fig. 54. Suture of *ceratites nodosus* (Brug). The arrow in the dorsal lobe points towards the aperture.

† Fig. 55. *Ammonites rostratus*, Sby. From the U. green-sand of Devizes, in the cabinet of W. Cunnington, Esq. *b*, front view of one of its partitions.

Syn., orbulites Lam. planulites, Montf.

Shell, discoidal; inner whirls more or less concealed; septa undulated; sutures lobed and foliated; siphuncle dorsal.

Distr., 530 sp. Trias—chalk. Coast of Chili (D'Orb.) Santa Fe de Bogota (Hopkins), New Jersey, Europe, and S. India.

Capt. Alexander Gerard discovered ammonites similar to our L. oolitic species, in the high passes of the Himalaya, 16,200 feet above the sea.

Section A. *Back, with an entire keel.*

1. *Arietes,*	L. oolites,	A. bifrons (pl. III., fig. 6), bisulcatus (pl. III., fig. 7).
2. *Falciferi,*	L. oolites,	A. serpentinus, radians, hecticus.
3. *Cristati,*	cretaceous,	A. cristatus, rostratus (fig. 55), varians.

B. *Back crenated.*

4. *Amalthei,*	ool.	A. amaltheus, cordatus, excavatus.
5. *Rhothomagenses,*	cret.	A. rhothomagensis (pl. III., fig. 4).

C. *Back sharp.*

6. *Disci.,*	oolitic,	A. discus, clypeiformis.

D. *Back channelled.*

7. *Dentati,*	cret.	A. dentatus, lautus.
	ool.	A. Parkinsoni, anguliferus.

E. *Back squared.*

8. *Armati,*	L. ool.	A. armatus, athletus, perarmatus.
9. *Capricorni,*	L. ool.	A. capricornus, planicostatus.
10. *Ornati,*	ool.	A. Duncani, Jason (pl. III., fig. 5).

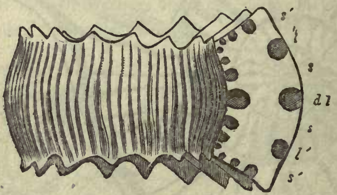

Fig. 56. *Ammonites coronatus.*[*]

F. *Back round, convex.*

11. *Heterophylli,*	L. ool.	A. heterophyllus (fig. 34).
12. *Ligati,*	cret.	A. planulatus (pl. III., fig. 3).
13. *Annulati,*	ool.	A. annulatus, biplex, giganteus.
14. *Coronati,*	ool.	A. coronatus (fig. 56), sublævis.
15. *Fimbriati,*	ool.	A. fimbriatus, lineatus, hircinus.

[*] Fig. 56. Profile of ammonites coronatus, Brug. (reduced ½ from D'Orbigny) Kelloway rock, France. *d l*, dorsal lobe; *s s*, dorsal saddles; *l' l'*, lateral lobes; *s' s'*, lateral saddles; accessory and ventral lobes. The number of accessory lobes increases with age.

16. *Cassiani*, 36 sp. of very variable form, and remarkable for the number and complexity of their lobes. Trias, Austrian Alps.

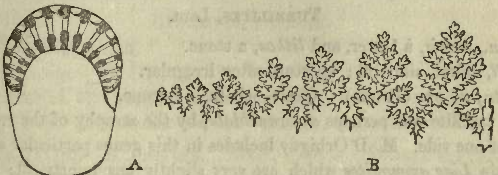

Fig. 57.*

Ex., A. Maximiliani (fig. 57), A. Metternichii.

CRIOCERAS, Leveille.

Etym., *krios*, a ram, and *ceras*, a horn.

Syn., tropæum, Sby.

Ex., C. cristatum, D'Orb. (pl. III., fig. 8).

Shell, discoidal; whirls separate.

Distr., 9 sp. Neocomian—Gault; Brit., France.

TOXOCERAS, D'Orb.

Etym., *toxon*, a bow, *ceras*, a horn.

Ex., T. annulare, D'Orb. (pl. III., fig. 12.)

Shell, bow-shaped; like an ammonite uncoiled.

Distr., 19 sp. Neocomian. Between this and *crioceras* and *ancyloceras* there are numerous intermediate forms.

ANCYLOCERAS, D'Orb.

Etym., *anculos*, incurved.

Ex., A. spinigerum (pl. III., fig. 10).

Shell, at first discoidal, with separate whirls; afterwards produced at a tangent and bent back again, like a hook or crosier.

Distr., 38 sp. Inf. oolite—chalk. S. America (Chile and Bogota), Europe.

SCAPHITES, Parkinson.

Etym., *scaphe*, a boat.

Ex., S. equalis (pl. III., fig. 9).

Shell, at first discoidal, with close whirls; last chamber detached and recurved.

Distr., 17 sp. Neocomian—chalk. Europe.

HELICOCERAS, D'Orb.

Etym., *helix* (*helicos*), a spiral, and *ceras*, horn.

Ex., H. rotundum, Sby, sp. pl. III., fig. 11 (diagram).

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* Fig. 57. Am. Maximiliani Klipstein. (= A. bicarinatus Münst). Trias, Hallstadt (copied from Quenstedt). A, Profile shewing the numerous lobes and saddles. B, suture of one side; *v*, dorsal saddle.

Shell, spiral, sinistral; whirls separate.

Distr., 11 sp. Inf. oolite?—chalk. Europe.

TURRILITES, Lam.

Etym., *turris*, a tower, and *lithos*, a stone.

Shell, spiral, sinistral; aperture often irregular.

Distr., 27 sp. (Bronn). Gault—chalk. Europe.

The turrilite was perhaps *di-branchiate*, by the atrophy of the respiratory organs of one side. M. D'Orbigny includes in this genus particular specimens of certain *Lias ammonites* which are very slightly unsymmetrical; the same species occur with both sides alike. He also makes a genus (*heteroceras*) of two turrilites, in which the last chamber is somewhat produced and recurved. *T. reflexus* (Quenstedt, T. 20, fig. 16) has its apex inflected and concealed.

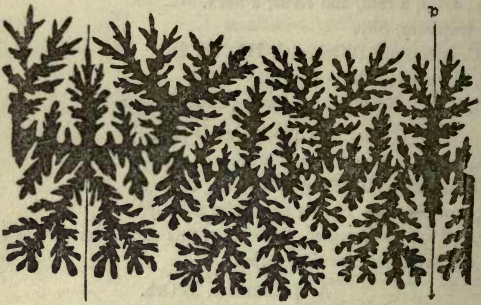

Fig. 58. *Sutures of hamites cylindraceus, Defr.**

HAMITES, Parkinson.

Etym., *hamus*, a hook.

Ex., H. attenuatus, pl. III., fig. 15.

Shell, hook-shaped, or bent upon itself more than once, the courses separate.

Distr., 58 sp. Neocomian—chalk. S. America (Tierra del Fuego)—Europe.

The inner courses of this shell probably break away or are "decollated" in the progress of its growth (Forbes). M. D'Orbigny has proposed a new genus, *hamulina*, for the 20 neocomian species.

PTYCHOCERAS, D'Orb.

Etym., *ptyche*, a fold.

Ex., P. emericianum, D'Orb., pl. III., fig. 14.

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* Fig. 58. Space between two consecutive sutures of the right side, from a specimen in the Brit. Mus. *a.* dorsal line. *b.* ventral. Baculite limestone, Fresville.

Shell, bent once upon itself; the two straight portions in contact.
Distr., 7 sp. Neocomian—chalk. Brit. France.

Baculites, Lamarck.

Etym., *baculus*, a staff.
Ex., B. anceps. Pl. III., fig. 13.
Shell, straight, elongated; aperture guarded by a dorsal process.
Distr., 11 sp. Neocomian—chalk. Europe, S. America (Chile).

Baculina, D'Orb. B. Rouyana. Neoc., France. Sutures not foliated.

The chalk of Normandy has received the name of *baculite limestone*, from he abundance of this fossil.

CLASS II. GASTEROPODA.

The gasteropods, including land-snails, sea-snails, whelks, limpets, and the ke, are the types of the *mollusca;* that is to say, they present all the leading atures of molluscous organization in the most prominent degree, and make ss approach to the appearance and condition of fishes than the cephalopods, nd less to the crustaceans and zoophytes than the bivalves.

Their ordinary and characteristic mode of locomotion is exemplified by the ommon garden-snail, which creeps by the successive expansion and contraction its broad muscular foot. These muscular movements may be seen following ach other in rapid waves when a snail is climbing a pane of glass.

The *nucleobranches* are "aberrant" gasteropods, having the foot thin and rtical; they swim near the surface of the sea, in a reversed position, or dhere to floating sea-weed.

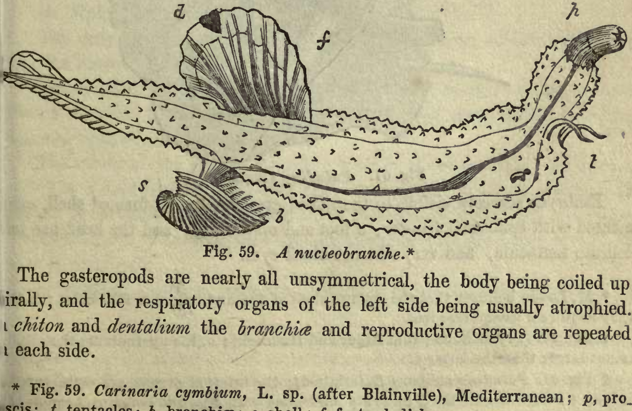

Fig. 59. *A nucleobranche.**

The gasteropods are nearly all unsymmetrical, the body being coiled up irally, and the respiratory organs of the left side being usually atrophied. *chiton* and *dentalium* the *branchiæ* and reproductive organs are repeated each side.

---

* Fig. 59. *Carinaria cymbium*, L. sp. (after Blainville), Mediterranean; *p*, proboscis; *t*, tentacles; *b*, branchiæ; *s*, shell; *f*, foot; *d*, disk.

A few species of *cymba, litorina, paludina,* and *helix,* are viviparous; the rest are oviparous.

When first hatched the young are always provided with a shell, though in many families it becomes concealed by a fold of the mantle, or it is speedily and wholly lost.*

The gasteropods form two natural groups; one breathing air (*pulmonifera*), the other water (*branchifera*). The air-breathers undergo no apparent metamorphosis; when born, they differ from their parents in size only. The water-breathers have at first a small nautiloid shell, capable of concealing them entirely, and closed by an operculum. Instead of creeping, they swim with a pair of ciliated fins springing from the sides of the head; and by this means are often more widely dispersed than we should be led to expect from their adult habits; thus some sedentary species of *calyptræa* and *chiton* have a greater range than the "paper-sailor," or the ever-drifting oceanic-snail.

At this stage, which may fairly be compared with the larval condition of insects, there is scarcely any difference between the young of *eolis* and *aplysia,* or *buccinum* and *vermetus.* (M. Edw.)

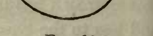

Fig. 60.†

The development of the branchiferous gasteropods may be observed with much facility in the common river-snails (*paludina*); which are viviparous, and whose oviducts in early summer contain young in all stages of growth some being a quarter of an inch in diameter.

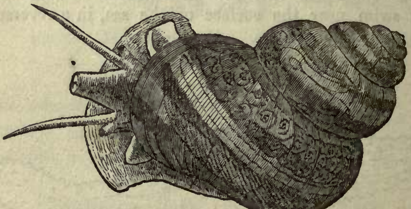

Fig. 61. *Paludina vivipara.*‡

Embryos scarcely visible to the naked eye have a well-formed shell, ornamented with epidermal fringes; a foot and operculum; and the head has long delicate tentacula, and very distinct black eyes.

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* M. Lovén believes that the embryo shell of the nudibranches falls off at the tim they acquire a locomotive foot.

† Fig. 60. Fry of Eolis (from Alder and Hancock); *o,* the operculum; the origina s not larger than the letter o.

‡ Fig. 61. *Paludina vivipara L.* (original); the internal organs are represented a if seen through the shell. The ovary, distended with eggs and embryos, occupies th right side of the body whirl; the gill is seen on the left; and between them the termination of the alimentary canal. Surrey Docks, June, 1850.

The development of the pulmoniferous embryo is best seen in the transparent eggs of the fresh-water limneïds; these are not hatched until the young have passed the larval condition, and their ciliated head-lobes (or veil), are superseded by the creeping disk, or foot.

The *shell* of the gasteropods is usually *spiral*, and univalve; more rarely *tubular*, or *conical*, and in one genus it is *multivalve*. The following are its principal modifications:

A. Regularly spiral,
  a. elongated or turreted; *terebra, turritella.*
  b. cylindrical; *megaspira, pupa.*
  c. short; *buccinum.*
  d. globular; *natica, helix.*
  e. depressed; *solarium.*
  f. discoidal; *planorbis.*
  g. convolute; aperture as long as the shell; *cypræa, bulla.*
  h. fusiform; tapering to each end, like *fusus.*
  i. trochi-form; conical, with a flat base, like *trochus.*
  k. turbinated; conical, with a round base, like *turbo.*
  l. few-whirled; *helix hæmastoma.* Pl. XII., fig. 1.
  m. many-whirled; *helix polygyrata.* Pl. XII., fig. 2.
  n. ear-shaped; *haliotis.*
B. Irregularly spiral; *siliquaria, vermetus.*
C. Tubular; *dentalium.*
D. Shield-shaped; *umbrella, parmophorus.*
E. Boat-shaped; *navicella.*
F. Conical or limpet-shaped; *patella.*
G. Multivalve and imbricated; *chiton.*

The only symmetrical shells are those of *carinaria, atlanta, dentalium,* and the limpets.*

Nearly all the spiral shells are *dextral*, or right-handed; a few are constantly *sinistral*, like *clausilia;* reversed varieties of many shells, both dextral and sinistral, have been met with.

The cavity of the shell is a single conical or spiral chamber; no gasteropod has a multilocular shell like the nautilus, but spurious chambers are formed by particular species, such as *triton corrugatus* (fig. 62), and *euomphalus pentangulatus;* or under special circumstances, as when the upper part of the spire is destroyed.

Some spiral shells are complete tubes, with the whirls separate, or scarcely in contact, as *scalaria, cyclostoma,* and *valvata;* but more commonly the inner side of the spiral tube is formed by the pre-existing whirls (fig. 62).

---

* The curve of the spiral shells and their opercula, and also of the Nautilus, is *a logarithmic spiral;* so that to each particular species may be annexed a number, indicating the ratio of the geometrical progression of the dimensions of its whirls. Rev. H. Moseley, "On geometrical forms of turbinated and discoid shells." *Phil. Trans. Lond.* 1838. *Pt.* 2, *p.* 351.

The axis of the shell, around which the whirls are coiled, is sometimes open or hollow; in which case the shell is said to be perforated, or *umbilicated* (e. g. *solarium*). The perforation may be a mere chink, or fissure (*riam*), as in *lacuna;* or it may be filled up by a shelly deposit, as in many *naticas.* In other shells, like the *triton,* the whirls are closely coiled, leaving only a pillar of shell, or *columella,* in the centre; such shells are said to be *imperforate.*

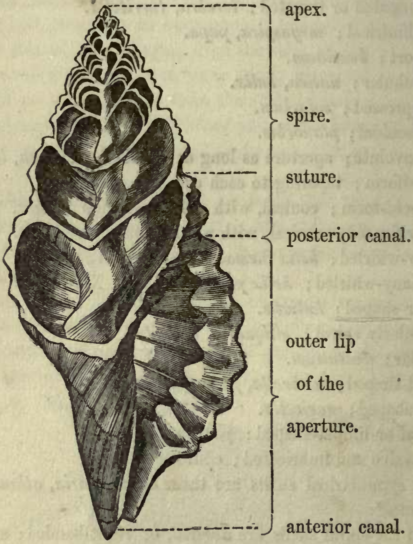

Fig. 62. ***Section of a spiral univalve.****

The *apex* of the shell presents important characters, as it was the *nucleus* or part formed in the egg; it is sinistral in the *pyramidellidæ,* oblique and spiral in the *nucleobranches* and *emarginulæ,* and mammillated in *turbinella pyrum* and *fusus antiquus.*

The apex is directed backwards in all except some of the *patellidæ,* in which it is turned forwards, over the animal's head. In the adult condition of some shells the apex is always truncated (or *decollated*), as in *cylindrella* and *bulimus decollatus;* in others it is only truncated when the animals have lived in acidulous waters (e. g. *cerithidea* and *pirena*), and specimens may be obtained from more favorable situations with the points perfect.

---

* Fig. 62. Longitudinal section of *triton corrugatus,* Lam., from a specimen in the cabinet of Mr. Gray. The upper part of the spire has been partitioned off many times successively.

The line or channel formed by the junction of the whirls is termed the *suture*.

The last turn of the shell, or *body-whirl*, is usually very capacious; in the females of some species the whirls enlarge more rapidly than in the males (e. g. *buccinum undatum*). The "base" of the shell is the opposite end to the apex, and is usually the front of the aperture.

The *aperture is entire* in most of the vegetable feeders (*holostomata*), but notched or produced into a *canal*, in the carnivorous families (*siphonostomata*); this canal, or siphon, is respiratory in its office, and does not necessarily indicate the nature of the food. Sometimes there is a posterior channel or canal, which is excurrent, or anal, in its function (e. g. *strombidæ* and *ovulum volva*); it is represented by the slit in *scissurella*, the tube of *typhis*, the perforation in *fissurella*, and the series of holes in *haliotis*.

The margin of the aperture is termed the *peristome;* sometimes it is continuous (*cyclostoma*), or becomes continuous in the adult (*carocolla*); very frequently it is "interrupted," the left side of the aperture being formed only by the body-whirl. The right side of the aperture is formed by the outer lip (*labrum*), the left side by the inner or columellar lip (*labium*), or partly by the body-whirl (termed the "wall of the aperture" by Pfeiffer).

The outer lip is usually thin and sharp in immature shells, and in some adults (e. g. *helicella* and *bulimulus*); but more frequently it is thickened; or reflected; or curled inwards (*inflected*), as in *cypræa;* or expanded as in pteroceras; or fringed with spines as in *murex*. When these fringes or expansions of the outer lip are formed periodically they are termed *varices*.

Lines of colour, or sculpture, running from the apex to the aperture are spiral or longitudinal, and others which coincide with the lines of growth are "transverse," as regards the whirls; but stripes of colour extending from the apex across the whirls are often described as "longitudinal" or "radiating," with respect to the entire shell.

Shells which are always concealed by the mantle are colourless, like *limax* and *parmophorus;* and those which are covered by the mantle-lobes when the animal expands, acquire a glazed or enamelled surface, like the cowries; when the shell is deeply immersed in the foot of the animal it becomes partly glazed, as in *cymba*. In all other shells there is an epidermis, although it is sometimes very thin and transparent.

In the interior of the shell the muscular impression is horse-shoe shaped, or divided into two scars; the horns of the crescent are turned towards the head of the animal.

The *operculum* with which many of the gasteropods close the aperture of their shell, presents modifications of structure which are so characteristic of the sub-genera, as to be worthy of particular notice. It consists of a horny layer, sometimes strengthened by the addition of calcarious matter on its exterior, and in its mode of growth it presents some resemblance to the shell itself. Its inner surface is marked by a muscular scar, whose lines bear no relation to the external lines of growth, and its form is unlike the muscular scar in the shell. It is developed in the embyro, within the egg, and the point from which it commences is termed the nucleus; many of the spiral and concentric forms fit the aperture of the shell with accuracy, the others only close the entrance partially, and in many genera, especially those with large apertures (e. g. *dolium, cassidaria, harpa, navicella*), it is quite rudimentary or obsolete.

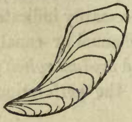

Fig. 63.

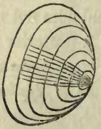

Fig. 64.

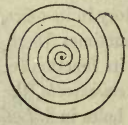

Fig. 65.

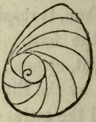

Fig. 66.

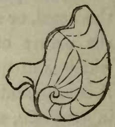

Fig. 67.

The operculum is described as—

Concentric, when it increases equally all round, and the nucleus is central or sub-central, as in *paludina* and *ampullaria* (pl. IX., fig. 26).

Imbricated or lamellar (fig. 64), when it grows only on one side, and the nucleus is marginal, as in *purpura, phorus,* and *paludomus.*

Claw-shaped, or unguiculate, (fig. 63, with the nucleus apical or in front), as in *turbinellus* and *fusus;* it is claw-shaped and serrated in *strombus* (fig. 69).

Spiral, when it grows only on one edge, and revolves as it grows; it is always *sinistral* in dextral shells.

Paucispiral, or few-whirled (fig. 66), as in *litorina.*

Sub-spiral, or scarcely spiral, in *melania.* Pl. VIII., fig. 25*.

Multispiral or many-whirled (fig. 65) as in *trochus,* where they sometimes amount to 20; the number of turns which the operculum makes is not determined by the number of whirls in the shell, but by the curvature of the opening, and the necessity that the operculum should revolve fast enough to fit it constantly (*Moseley*).

It is said to be *articulated* when it has a projection, as in nerita (fig. 67).

Too much importance, however, must not be attached to this very variable plate, as an aid to classification; it is present in some species of *voluta, oliva, conus, mitra,* and *cancellaria,* but absent in others; it is (indifferently) horny or shelly in the species of *ampullaria* and *natica;* in *paludina* it is concentric, in *paludomus lamellar,* in *valvata* spiral; in *solarium* and *cerithium,* it is *multispiral* or *paucispiral.*

Some of the gasteropoda can suspend themselves by glutinous threads, like *litiopa* and *rissoa parva,* which anchor themselves to sea-weeds (Gray), and *cerithidea* (fig. 68), which frequently leaves its proper element, and is found hanging in the air (Adams). A West India land-snail (*cyclostoma suspensum*) also suspends itself (Guilding). The origin of these threads has not been explained; but some of the *limaces* lower themselves to the ground by a thread which is not secreted by any particular gland, but derived from the exudation over the general surface of the body (Lister; D'Orbigny).

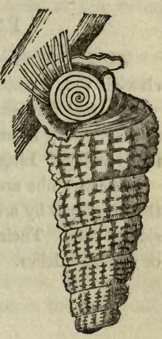

Fig. 68.

The division of this extensive class into orders and families, has engaged the attention of many naturalists, and a variety of methods have been proposed. Cuvier's classification was the first that possessed much merit, and several of his orders have since been united with advantage.

System of Cuvier.	System now adopted.
Class. GASTEROPODA.	
Order 1. Pectinibranchiata	Ord. *Prosobranchiata,* M. Edw.
2. Scutibranchiata	
3. Cyclobranchiata	
4. Tubulibranchiata	
5. Pulmonata	Ord. *Pulmonifera.*
6. Tectibranchiata	Ord. *Opisthobranchiata,* M. Edw.
7. Inferobranchiata	
8. Nudibranchiata	
Class. HETEROPODA.	Ord. *Nucleobranchiata.* Bl.

ORDER I. PRÓSOBRANCHIÁTA.

Abdomen well developed, and protected by a shell, into which the whole animal can usually retire. *Mantle* forming a vaulted chamber over the back of the head, in which are placed the excretory orifices, and in which the branchiæ are almost always lodged. *Branchiæ* pectinated, or plume-like, situated (*proson*) in advance of the heart. *Sexes* distinct. (M. Edwards.)

SECTION A. SIPHONOSTÓMATA. Carnivorous Gasteropods.

Shell spiral, usually imperforate; aperture notched or produced into a canal in front. *Operculum* horny, lamellar.

Animal provided with a retractile proboscis; eye-pedicels connate with the tentacles; margin of the mantle prolonged into a siphon, by which water is conveyed into the branchial chamber; gills 1 or 2, comb-like, placed obliquely over the back. Species all marine.

FAMILY I. Strómbidæ. Wing-shells.

Shell with an expanded lip, deeply notched near the canal. *Operculum* claw-shaped, serrated on the outer edge.

Animal furnished with large eyes, placed on thick pedicels; tentacles slender, rising from the middle of the eye-pedicels. Foot narrow, ill adapted for creeping. Lingual teeth single; uncini, three on each side.

The strombs are carrion feeders, and, for molluscous animals, very active; they progress by a sort of leaping movement, turning their heavy shell from side to side. Their eyes are more perfect than those of the other gasteropods, or of many fishes.

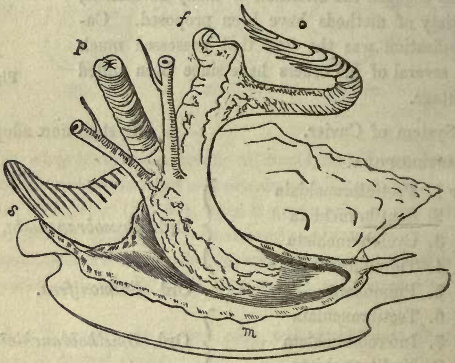

Fig. 69.[*]

Strombus, L. Stromb.

Etym., *strombos,* a top.

Type, S. pugilis. Pl. IV., fig. 1.

Shell rather ventricose, tubercular or spiny; spire short; aperture long, with a short canal above, and truncated below; outer lip expanded, lobed above, and sinuated near the notch of the anterior canal. Lingual teeth (*S. floridus*) 7 cusped; uncini, 1 tri-dentate, 2, 3 claw-shaped, simple.[†]

Distr., 60 species. West Indies, Mediterranean, Red Sea, India, Mauritius, China, New Zealand, Pacific, West America. On reefs, at low water, and ranging to 10 fathoms.

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[*] Fig. 69. Strombus auris-Dianæ, L. (after Quoy and Gaimard), Amboina. *p*, proboscis, between the eye-pedicels; *f*, foot, folded up; *o*, operculum; *m*, border of the mantle; *s*, respiratory siphon.

[†] The lingual dentition of *strombus* resembles that of aporrhais, and is unlike that of the whelks; but it is more probable that aporrhais is the *representative* of strombus, than that it is very closely allied.

Fossil, 5 cretaceous species ; 3 sp. Miocene—. South Europe. There is a group of small shells in the eocene tertiary strata of England and France, nearly related to the living *S. fissurellus* L., some of which have been placed with *rostellaria,* because the notch in the outer lip is small, or obsolete. They probably constitute a sub-genus, to which Swainson's name *strombidia,* might be applied. *Example,* S. Bartonensis. Pl. IV., fig. 2.

The fountain-shell of the West Indies, *S. gigas,* L., is one of the largest living shells, weighing sometimes four or five pounds; its apex and spines are filled up with solid shell as it becomes old. Immense quantities are annually imported from the Bahamas for the manufacture of cameos, and for the porcelain works; 300,000 were brought to Liverpool alone in the last year, 1850 (Mr. Archer).

PTERÓCERAS, Lam. Scorpion-shell.

Etym., pteron, a wing, and *ceras,* a horn.

Type, P. lambis. Pl. IV., fig. 3.

Shell like strombus when young; outer lip, of the adult, produced into several long claws, one of them close to the spire, and forming a posterior canal.

Distr., 10 sp. India, China.

Fossil, nearly 100 sp. are enumerated by D'Orbigny, ranging from the lias to the upper chalk; many of them are more nearly related to aporrhaïs (*cerithiadæ*).

ROSTELLARIA, Lam.

Etym., rostellum, a little beak.

Syn., fusus, Humphreys.

Example, R. curta. Pl. IV., fig. 4.

Shell with an elongated spire; whirls numerous, flat; canals long, the posterior one running up the spire; outer lip more or less expanded, with only one sinus, and that close to the beak.

Distr., 5 sp. Red Sea, India, Borneo, China. *Range,* 30 fathoms.

Fossil, 70 sp. Neocomian — chalk (=aporrhaïs ?). 6 sp. Eocene—. Britain, France, &c.

The older tertiary species have the outer lip enormously expanded, and smooth-edged; they constitute the section *hippochrenes* of Montfort (e. g. Rost. ampla, Solander. London clay).

Sub-genus? Spinigera, D'Orb. 1847. Shell like *rostellaria;* whirls keeled; keel developed into a slender spine on the outer lip, and two on each whirl, forming lateral fringes, as in *ranella.* Fossil, 5 sp. Inf. oolite—chalk. Britain, France.

SERAPHS, Montfort. (Terebellum, Lam.)

Etym., diminutive of *terebra*, an auger.

Type, S. terebellum (Linnæus sp.) = T. subulatum, Lam. Pl. IV., fig. 5.

Shell smooth, sub-cylindrical; spire short or none; aperture long and narrow, truncated below; outer lip thin.

Distr., 1 sp. China. Philippines, 8 fms. (Cuming.)

Fossil, 5 sp. Eocene—. London, Paris.

The animal of *terebellum* has an operculum like *strombus*; its eye-pedicels are simple, without tentacles (Adams). In one fossil species, *T. fusiforme*, there is a short posterior canal, as in *rostellaria*.

FAMILY II. MURICIDÆ.

Shell with a straight anterior canal; aperture entire behind.

Animal with a broad foot; eyes sessile on the tentacles, or at their base; branchial plumes 2. *Lingual ribbon* long, linear; *rachis* armed with a single series of dentated teeth; *uncini*, single. Predatory, on other *mollusca*.

MUREX (Pliny) L.

Types, M. palma-rosæ, Pl. IV., fig. 10. M. tenuispina, Pl. IV., fig. 9. M. haustellum, Pl. IV., fig. 8. M. radix, pinnatus.

Shell ornamented with three or more continuous longitudinal varices; aperture rounded; beak often very long; canal partly closed; *operculum* concentric, nucleus sub-apical (Pl. IV., fig. 10); lingual dentition (M. erinaceus), teeth single, 3 crested; uncini single, curved.

Distr., 180 sp. World-wide; most abundant on the W. coast of tropical America, in the Chinese Sea, West coast of Africa, West Indies; ranging from low water to 25 fathoms, rarely at 60 fathoms.

Fossil, 160 sp. Eocene—. Britain, France, &c.

A few of the species usually referred to this genus, belong to *pisania* and *trophon*.

The murices appear to form only one-third of a whirl annually, ending in a *varix;* some species form intermediate varices of less extent. *M. erinaceus* a very abundant species on the coasts of the channel, is called "sting-winkle" by fishermen, who say it makes round holes in the other shell-fish with its beak. See p. 27. The ancients obtained their purple dye from species of *murex;* the small shells were bruised in mortars, the animals of the larger ones taken out. (F. Col.) Heaps of broken shells of the *M. trunculus* and caldron-shaped holes in the rocks may still be seen on the Tyrian shore. (Wilde.) On the coast of the Morea, there is similar evidence of the employment of *M. brandaris* for the same purpose. (M. Boblaye.)

TYPHIS, Montfort.

Etym., *typhos*, smoke.

Type, T. pungens. Pl. IV.. fig. 11.

Shell like murex; but having tubular spines between the varices, of which the last is open, and occupied by the excurrent canal.

Distr., 8 sp. Medit., W. Africa, Cape, India, W. America. —50 fms.

Fossil, 8 sp. Eocene—. London, Paris.

PISANIA, Bivon, 1832.

Etym., a native of (the coast near) *Pisa*, in Tuscany.

Syn., Pollia, Enzina, and Euthria (Gray).

Types, P. maculosa. Pl. IV., fig. 14 (Enzina) zonata. Pl. IV., fig. 15.

Shell with numerous indistinct varices, or smooth and spirally striated; canal short; inner lip wrinkled; outer lip crenulated.

Operculum ovate, acute; nucleus apical.

The *pisaniæ* have been usually confounded with *buccinum*, *murex*, and *ricinula*.

Distr., about 120 sp. W. Indies, Africa, India, Philippines, S. Seas, W America.

Fossil, ? sp. Eocene—. Brit., France, &c.

RANELLA, LAM. Frog-shell.

Syn., Apollon, Montfort and Gray.

Types, R. granifera. Pl. IV., fig. 12. R. spinosa.

Shell with two rows of continuous varices, one on each side.

Operculum ovate, nucleus lateral.

Distr., 50 sp. Medit., Cape, India, China, Australia, Pacific, W. America. *Range*, low-water to 20 fms.

Fossil, 23 sp. Eocene—.

TRITON. Lam.

Etym. *Triton*, a sea-deity. *Syn.*, persona (Montf. Gray).

Type, T. tritonis, L. sp. Pl. IV., fig. 13.

Shell with disconnected varices; canal prominent; lips denticulated.

Operculum ovate, sub-concentric.

Distr., 100 sp. W. Indies, Medit., Africa, India, China, Pacific, W. America. Ranging from low-water to 10 or 20 fathoms; one minute species has been dredged at 50 fathoms.

Fossil, 45 sp. Eocene—. Brit., France, &c. Chile.

The great triton (*T. tritonis*) is the conch blown by the Australian and Polynesian Islanders. A very similar sp. (*T. nodiferus*) is found in the Medit., and a third in the W. Indies.

FASCIOLARIA, Lam.

Etym., *fasciola*, a band.

Type, F. tulipa. Pl. V., fig. 1.

Shell fusiform, elongated; whirls round or angular; canal open; columellar lip tortuous, with several oblique folds. *Operc.* claw-shaped. F. gigantea of the S. Seas, attains a length of nearly two feet.

Distr., 16 sp. W. Indies, Medit., W. Africa, India, Australia, S. Pacific, W. America.

Fossil, 28 sp., U. chalk—. France.

TURBINELLA, Lam.

Etym., diminutive of *turbo,* a top.

Type, T. pyrum. Pl. V., fig. 2.

Shell thick; spire short; columella with several transverse folds. Operculum claw-shaped. Fig. 63. The shank-shell (*T. pyrum*) is carved by the Cingalese, and reversed varieties of it, from which the priests administer medicine, are held sacred.

Distr., 70 sp. W. Indies, S. America, Africa, Ceylon, Philippines, Pacific, W. America.

Fossil, 20 sp. Miocene—.

Sub-genera. Cynodonta (Schum.) T. cornigera. Pl. V., fig. 3.

Latirus (Montf.) T. gilbula. Pl. V., fig. 4.

Cuma (Humphr.) T. angulifera, inner lip with a single prominent fold operculum like *purpura.*

Lagena (Schum.) T. Smaragdula, L. sp. N. Australia.

CANCELLARIA, Lam.

Etym., cancellatus, cross-barred.

Type, C. reticulata. Pl. V., fig. 5.

Shell cancellated; aperture channelled in front: columella with several strong oblique folds; no operculum. The animals are vegetable feeders. (Desh.)*

Distr., 70 sp. W. Indies, Medit., W. Africa, India, China, California.

Fossil, 60 sp. Eocene—. Britain, France, &c.

TRICHOTROPIS, Broderip, 1829.

Etym., Thrix, (trichos) hair, and *tropis,* keel.

Type, T. borealis, Pl. VI., fig. 8. (= ? *Admete,* Phil., no operculum.)

Shell thin, umbilicated; spirally furrowed; the ridges with epidermal fringes; columella obliquely truncated; operc. lamellar, nucleus external.

Animal with a short broad head; tentacles distant, with eyes on the middle; proboscis long, retractile.

Lingual dentition similar to *strombus; teeth* single, hamate, denticulated; *uncini* 3: 1 denticulate 2 and 3 simple.

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* *Cancellaria* and *trichotropis* form a small natural family connected with *cerithiadæ* and *strombidæ.*

Distr., 8 sp. Northern seas. U. States, Greenland, Melville Island, Behring's Straits, N. Brit. 15—80 fms.

Fossil, 1 sp. Miocene—. Brit.

PYRULA, Lam. Fig-shell.

Etym., diminutive of *pyrus*, a pear.

Syn., Ficula, Sw. Sycotypus, Br., Cassidula, Humph. Cochlidium, Gray.

Type, P. ficus. (Pl. V., fig. 6.)

Shell pear-shaped; spire short; outer lip thin; columella smooth: canal long, open. No operculum in the typical species.

Distr., 39 sp. W. Indies, Ceylon, Australia, China, W. America.

Fossil, 30 sp. Neocomian—. Europe, India. Chile.

Pyrula ficus has a broad foot, truncated and horned in front; the mantle forms lobes on the sides, which nearly meet over the back of the shell. Chinese seas, in 17—35 fms. water. (Adams.)

Sub-genera. Fulgur, Montf. P. perversa. (= *Pyrella*, Sw. P. spirillus.)

Rapana, Schum. P. bezoar, shell perforated. Operc. lamellar, nucleus external.

Myristica. Sw. P. melongena. Pl. V., fig. 7. Operc. pointed, curved.

FUSUS, Lam. Spindle-shell.

Syn., Colus, Humph. Leiotomus, Sw. Strepsidura, Sw.

Type, F. colus. Pl. V., fig. 8.

Shell fusiform; spire many-whirled; canal straight, long; operculum ovate, curved, nucleus apical. Pl. V., fig. 9*.

Distr., 100 sp. World-wide. The typical sp. are sub-tropical. Australia, New Zealand, China, Senegal, U. States, W. America, Pacific.

Fossil, 320 sp. Bath oolite? Gault—Eocene—. Brit. &c.

Sub-genera, *Trophon*, Montf. F. magellanicus, Pl. IV., fig. 16. 14 sp. Antarctic and Northern seas. Brit. coast. 5—70 fathoms. *Fossil*, Chile, Brit.

Clavella, Sw. (cyrtulus, Hinds) body-whirl ventricose, suddenly contracted in front; canal long and straight. Resembling a turbinella, without plaits. 2 sp. Marquesas, Panama. *Fossil*, Eocene. F. longævus (Solander), Barton, &c.

Chrysodomus, Sw. F. antiquus (var.) Pl. V., fig. 9. Canal short; apex papillary; lingual dentition like buccinum, 12 sp. Spitzbergen, Davis's Straits, Brit., Medit., Kamschatka, Oregon. Low water to 100 fms. *Fossil*, pliocene. Brit., Sicily.

Pusionella, Gray. F. pusio, L. sp. (=F. nifat, Lam.), columella keeled. Operc., nucleus internal, 7 sp. Africa, India. *Fossil*, tertiary. France.

Fusus colosseus and proboscidalis, Lam., are two of the largest living gasteropods. *Fusus* (*chrysodomus*) *antiquus*, called the red-whelk on the coasts of the channel, and "Buckie" in Scotland, is extensively dredged for the markets, being more esteemed than the *buccinum*. It is the "roaring buckie," in which the sound of the sea may always be heard. In the Zetland cottages it is suspended horizontally, and used for a lamp; the cavity containing the oil, and the canal the wick. (Fleming.) The reversed variety (F. contrarius, Sby) is found in the Medit., and on the coast of Spain; it abounds in the pliocene tertiary (crag) of Essex. The *fusus deformis*, a similar sp., found off Spitzbergen, is always reversed.

FAMILY III. Buccinidæ.

Shell notched in front; or with the canal abruptly reflected, producing a kind of varix on the front of the shell.

Animal similar to *murex*; lingual ribbon long and linear, (fig. 16) rachidian teeth single, transverse, dentated in front; uncini single. Carnivorous.

Buccinum, L. Whelk.

Etym., *buccina*, a trumpet, or triton's-shell.

Type, B. undatum. Pl. V., fig. 10.

Shell few whirled; whirls ventricose; aperture large; canal very short, reflected; operculum lamellar, nucleus external. (See *pisania.*)

Distr., 20 typical species. Northern and Antarctic seas. Low water to 100 fms. (Forbes). (B ? clathratum, 136 fms., off Cape.)

Fossil, 130 sp., including *pisania*, &c. Gault ?—Miocene—. Brit., France.

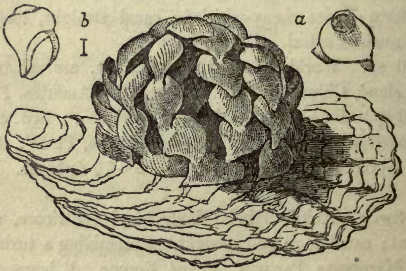

Fig. 70. *Nidamental capsules of the Whelk.**

The whelk is dredged for the market, or used as bait by fishermen; it may be taken in baskets, baited with dead fish. Its nidamental capsules are aggregated in roundish masses, which, when thrown ashore, and drifted by the wind resemble corallines. Each capsule contains five or six young, which, when hatched, are like fig. 70, *b* : *a*, represents the inner side of a single capsule, shewing the round hole, from which the fry have escaped.

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* Fig. 70. From a small specimen, on an oyster-shell, in the cabinet of Albany Hancock, Esq. The line at *b*, represents the length of the young shell.

Sub-genus. Cominella, Gray. *Ex. B. limbosum, purpura maculosa,* &c. Operculum as in *fusus.* About 12 sp.

PSEUDOLIVA, Swainson.

Etym., named from its resemblance to *oliva,* in form.

Syn., sulco-buccinum, D'Orb. Gastridium (Gray), G. Sowerby.

Type, P. plumbea. Pl. V., fig. 12.

Shell globular, thick; with a deep spiral furrow near the front of the body-whirl, forming, as in *monoceros,* a small tooth on the outer lip; spire short, acute; suture channelled; inner lip callous aperture notched in front; operculum? Animal unknown.

Distr., 6 sp.? W. America.

Fossil, 5 sp. Eocene. Brit., France, Chile.

? ANOLAX (Roissy), Conrad. Lea.

Etym., *an aulax,* without furrow.

Syn., buccinanops, D'Orb. Leiodomus, Sw. Bullia, Gray.

Types, A. gigantea, Lea. Buc. lævigatum. B. semiplicata, Pl. V., fig. 14.

Shell variable; like buccinum, pseudoliva, or terebra; sutures enamelled; inner lip callous.

Animal without eyes; foot very broad; tentacles long and slender; operculum pointed, nucleus apical.

Distr., 26 sp. Brazil, W. Africa, Ceylon, Pacific, W. America.

Fossil, 3 sp. Eocene—. N. America, France.

? HALIA, Risso.

Etym., *halios,* marine. *Syn.*, priamus, Beck.

Types, bulla helicoides (Brocchi). Miocene, Italy. Helix priamus (Meuschen). Coast of Guinea?

Shell like *achatina;* ventricose, smooth; apex regular, obtuse; operc.? The fossil species occurs with marine shells, and sometimes coated by a coral (*lepralia*).

TEREBRA, Lamarck. Auger-shell.

Syn., acus, Humph. Subula, Bl. Dorsanum, Gray.

Type, T. maculata. Pl. V., fig. 13.

Shell long, pointed, many-whirled; aperture small; canal short; operc. pointed, nucleus apical.

Animal blind, or with eyes near the summit of minute tentacles.

Distr., 109 sp., mostly tropical. Medit. (1 sp.) India, China, W. America.

Fossil, 24 sp. Eocene—. Brit., France, Chile.

EBURNA, Lamarck. Ivory-shell.

Etym., *ebur,* ivory. *Syn.*, latrunculus, Gray.

Type, E. spirata. Pl. V., fig. 11.

Shell umbilicated when young; inner lip callous, spreading and covering the umbilicus of the adult; *operculum* pointed, nucleus apical.

Distr., 9 sp. Red Sea, India, Cape, Japan, China, Australia. Solid, smooth shells, which have usually lost their epidermis, and are pure white, spotted with dark red; the animal is spotted like the shell. 14 fms. (Adams.)

NASSA, Lam. Dog-whelk.

Etym., *nassa*, a basket used for catching fish.

Syn., desmoulinsia and northia, Gray.

Type, N. arcularia. Pl. V., fig. 15.

Shell like buccinum; columellar lip callous, expanded, forming a tooth-like projection near the anterior canal. *Operc.* ovate, nucleus apical. Lingual teeth arched, pectinated; uncini, with a basal tooth.

The animal has a broad foot, with diverging horns in front, and two little tails behind. *N. obsoleta* (Say) lives within the influence of fresh water and becomes eroded. *N. reticulata, L.*, is common on the English shores, at low-water, and is called the dog-whelk by fishermen.

Distr., 68 sp. Low-water—50 fms. World-wide. Arctic, Tropical and Antarctic Seas.

Fossil, 19 sp. Eocene—. Brit., &c., N. America.

Sub-genus, *cyllene*, Gray. C. Oweni, Pl. V., fig. 17. Outer lip with a slight sinus near the canal; sutures channelled. W. Africa, Sooloo Islands, Borneo. *Fossil*, Miocene, Touraine.

Cyclonassa, Swainson. C. neritea, Pl. V., fig. 16.

PHOS, Montfort.

Etym., *phos*, light. *Syn.*, rhinodomus, Sw.

Type, P. senticosus, Pl. V., fig. 18.

Shell like nassa; cancellated; outer lip striated internally, with a slight sinus near the canal; columella obliquely grooved.

The animal has slender tentacles, with the eyes near their tips.

Distr., 30 sp. (Cuming.) Red Sea, Ceylon, Philippines, Australia, W. America.

? RINGICULA, Deshayes.

Etym., diminutive of *ringens*, from *ringo*, to grin.

Type, R. ringens, Pl. V., fig. 21.

Shell minute, ventricose, with a small spire; aperture notched, columella callous, deeply plaited; outer lip thickened and reflected.

Distr., 4 sp.? Medit., India, Philippines, Gallapagos.

Fossil, 9 sp., Miocene—. Brit., France. *Ringicula* is placed with *nassa* by Mr. Gray, and Mr. S. Wood; it appears to us very nearly allied to *cinulia* (=*avellana*, D'Orb.) in *tornatellidæ.*

PURPURA (Adans), Lam. Purple.

Type, P. persica, Pl. VI., fig. 1.

Shell striated, imbricated or tuberculated; spire short; aperture large, slightly notched in front; inner lip much worn and flattened. Operc. lamellar, nucleus external. Pl. VI., fig. 2. Lingual dentition like murex erinaceus; teeth transverse, 3 crested; uncini small, simple.

Many of the *purpuræ* produce a fluid which gives a dull crimson dye; it may be obtained by pressing on the operculum. *P. lapillus* abounds on the British coast at low-water, amongst sea-weed; it is very destructive to mussel-beds (Fleming).

Distr., 140 sp. W. Indies, Brit., Africa, India, New Zealand, Pacific, Chile, California, Kamschatka. From low-water—25 fathoms.

Fossil, 30 sp. Miocene—. Brit., France, &c.

Sub-genus. Concholepas, Favan. C. lepas (Gmelin sp.) Pl. VI., fig. 3. Peru. The only sp. differs from purpura in the size of its aperture, and smallness of the spire.

? PURPURINA (Lycett, 1847). D'Orb.

Shell, ventricose, coronated; spire, short; aperture, large, scarcely notched in front.

Fossil, 9 sp., Bath-oolite. Brit. France. The type, *P. rugosa,* somewhat resembles *purpura chocolatum* (Duclos), but the genus probably belongs to an extinct group.

MONOCEROS, Lam.

Etym., monos, one; *ceras,* horn.

Syn., acanthina, Fischer. Chorus, Gray.

Type, M. imbricatum. Pl. VI., fig. 4 (Buc. monoceros, Chemn).

Shell, like purpura; with a spiral groove on the whirls, ending in a prominent spine on the outer lip. This genus is retained on account of its geographical curiosity; it consists of sp. of *purpura, lagena, turbinella, pseudoliva,* &c.

Distr., 18 sp. W. coast of America.

Fossil, tertiary. Chile.

M. gigantens (chorus) has the canal produced like *fusus. M. cingulatum* is a *turbinella,* and several sp. belong more properly to *lagena.*

PEDICULARIA, Swainson.

Type, P. sicula. Pl. VI., fig. 5 (*thyreus, Phil.*).

Shell very small, limpet-like; with a large aperture, channelled in front, and a minute, lateral spire. *Lingual dentition* peculiar; teeth single, hooked, denticulated; *uncini,* 3; 1, four-cusped, 2, 3, elongated, three-spined.

Distr., 1 sp. Sicily, adhering to corals. Closely allied to *purpura madreporarum*, Sby. Chinese Sea.

RICINULA, Lam.

Etym., dimunitive of *ricinus*, the (fruit of the) castor-oil plant.

Ex., R. arachnoïdes. Pl. VI., fig. 9 (=murex ricinus L.).

Shell, thick, tuberculated, or spiny; aperture contracted by callous projections on the lips. Operc. as in purpura.

Distr. 25 sp. India, China, Philippines, Australia, Pacific.

Fossil, 3 sp. Miocene—. France.

PLANAXIS, Lam.

Type, P. sulcata. Pl. VI., fig. 6. *Syn.*, quoyia and leucostoma.

Shell, turbinated; aperture notched in front; inner lip callous, channelled behind; operculum *subspiral* (quoyia) or semi-ovate. Pl. VI., fig. 7.

Distr., 11 sp. W. Indies, Red Sea, Bourbon, India, Pacific, and Peru.

Fossil, miocene?

Small coast shells, resembling periwinkles, with which Lamarck placed them.

MAGILUS, Montf., 1810.

Syn., campulote, Guettard, 1759. Leptoconchus, Rüppell.

Type, M. antiquus. Pl. V., figs. 19, 20.

Shell, when young, spiral, thin; aperture channelled in front; adult, prolonged into an irregular tube, solid behind; operculum lamellar.

Distr., 1 sp.? Red Sea. Mauritius.

The magilus lives fixed amongst corals, and grows upwards with the growth of the zoophytes in which it becomes immersed; it fills the cavity of its tube with solid shell, as it advances.

CASSIS, Lam. Helmet-shell.

Syn., bezoardica, Schum. Levenia, Gray. Cypræcassis, Stutch.

Type, C. flammea. Pl. VI., fig. 14.

Shell, ventricose, with irregular varices; spire, short; aperture long, outer lip reflected, denticulated; inner lip spread over the body-whirl; canal sharply recurved. Operculum small, elongated; nucleus in the middle of the straight inner edge.

Distr., 34 sp. Tropical seas; in shallow water. W. Indies, Medit., Africa, China, Japan, Australia, New Zealand, Pacific, Mexico.

Fossil, 36 sp. Eocene—. Chile, France.

The queen-conch (C. madagascariensis) and other large species, are used in the manufacture of shell cameos, p. 46. The periodic mouths (*varices*) which are very prominent, are not absorbed internally as the animal grows.

ONISCIA, Sowerby.

Etym., *oniscus*, a wood louse. *Syn.*, morum, Bolten.

Type, O. oniscus; O. cancellata, pl. VI., fig. 15.

Shell, with a short spire, and a long narrow aperture, slightly truncated in front; outer lip thickened, denticulated; inner lip granulated.

Distr., 6 sp. W. Indies, China, Gallapagos. (20 fms.)

Fossil, 3 sp. Miocene.

CITHARA, Schumacher.

Etym., *cithara*, a guitar. *Syn.*, mangelia, Reeve (not Leach).

Type, cancellaria citharella, Lam. (cithara striata, Schum.)

Shell, fusiform, polished, ornamented with regular longitudinal ribs; aperture linear, truncated in front, slightly notched behind; outer lip margined, denticulated within; inner lip finely striated. Operc.

Distr., above 50 sp. of this pretty little genus were discovered by Mr. Cuming, in the Philippine Islands.

CASSIDARIA, Lam.

Etym., *cassida*, a helmet.

Syn., morio, Montf. Sconsia, Gray.

Type, C. echinophora. Pl. VI., fig. 13.

Shell, ventricose; canal produced, rather bent. No operculum.

Distr., 5 sp. Medit.

Fossil, 10 sp. Eocene—. Brit., France, &c.

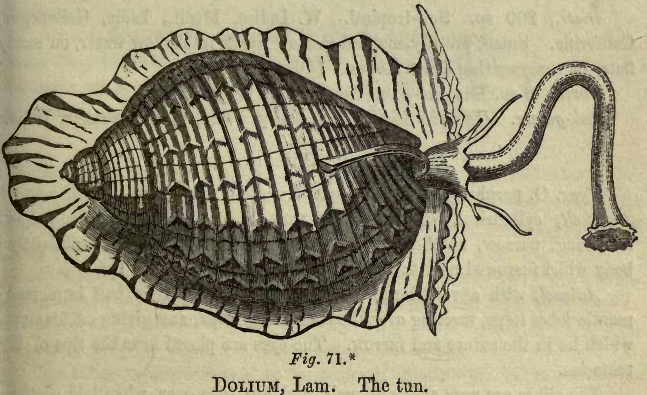

Fig. 71.*

DOLIUM, Lam. The tun.

Type, D. galea. Pl. VI., fig. 12.

Shell, ventricose, spirally furrowed; spire small; aperture very large; outer lip crenated. No operc.

Distr., 14 sp. Medit., Ceylon, China, Australia, Pacific.

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* D. perdix, L. sp. ½ nat. size (after Quoy). Vanicoro, Pacific. The proboscis is exserted, and the siphon recurved over the front of the shell.

Fossil, 7 sp. (?Chalk. Brit.) Miocene—. S. Europe.

Sub-genus, malea, Valenc. (D. personatum) outer lip thickened and denticulated; inner lip with callous prominences.

HARPA, Lam. Harp-shell.

Type, H. ventricosa. Pl. VI., fig. 11. (=Buc. harpa, L.)

Shell, ventricose; with numerous ribs, at regular intervals; spire small; aperture large, notched in front. No operc.

The animal has a very large foot, with the front crescent-shaped, and divided by deep lateral fissures from the posterior part, which is said to separate spontaneously when the animal is irritated. Mostly obtained from deep-water, and soft bottoms.

Distr., 9 sp. Mauritius, Ceylon, Philippines, Pacific.

Fossil, 4 sp. Eocene—. France.

COLUMBELLA, Lam.

Etym., diminutive of *columba,* a dove.

Type, C. mercatoria. Pl. VI., fig. 10.

Shell, small; with a long narrow aperture; outer lip thickened (especially in the middle), dentated; inner lip crenulated. Operculum very small lamellar.

Distr., 200 sp. Sub-tropical. W. Indies, Medit., India, Gallapagos, California. Small, prettily-marked shells; living in shallow water, on sandy flats, or congregating about stones. (Adams.)

Fossil, 8 sp. Miocene—. (The Brit. sp. are *pisaniæ*).

Sub-genus. Columbellina, D'Orb. 4 sp. Cretaceous. France, India.

OLIVA, Lam. Olive, rice-shell.

Type, O. porphyria. Pl. VI., fig. 16. *Syn.,* strephona, Brown.

Shell, cylindrical, polished; spire very short, suture channelled; aperture long, narrow, notched in front; columella callous, striated obliquely; body whirl furrowed near the base. No operc. in the typical sp.

Animal, with a very large foot, in which the shell is half immersed; mantle lobes large, meeting over the back of the shell, and giving off filament which lie in the suture and furrow. The eyes are placed near the tips of th tentacles.

The olives are very active animals, and can turn over, when laid on thei back; near low water they may be seen gliding about or burying in the sand as the tide retires; they may be taken with animal baits, attached to line. They range downwards to 25 fms.

Distr., 117 sp. Sub-tropical, W. and E. America. W. Africa, Indi, China, Pacific.

Fossil, 20 sp. Eocene—. Brit., France, &c.

Sub-genera. *Olivella,* Sw. O. jaspidea, pl. VI., fig. 19.
Animal with small, acute frontal lobes. Operc. nucleus sub-apical.
Scaphula, Sw. O utriculus, pl. VI., fig. 18.
Frontal lobes large, rounded, operculate.
Agaronia, Gray. O. hiatula, pl. VI., fig. 17.
No eyes or tentacles. Frontal lobes moderate, acute.

ANCILLARIA, Lam.

Etym., *ancilla,* a maiden.

Types, A. subulata, pl. VI., fig. 20. A. glabrata, pl. VI. fig. 21.

Shell like oliva; spire produced, and entirely covered with shining enamel. Operc. minute, thin, pointed. Lingual teeth pectinated. Uncini simple, hooked.

Animal like oliva; said to use its mantle-lobes for swimming. (D'Orb.) In *A. glabrata,* a space resembling an umbilicus, is left between the callous inner lip and the body whirl.

Distr., 23 sp. Red Sea, India, Madagascar, Australia, Pacific.

Fossil, 21 sp. Eocene—. Brit., France, &c.

FAMILY IV. CONIDÆ, Cones.

Shell inversely conical; aperture long and narrow; outer lip notched at or near the suture; operculum minute, lamellar.

Animal, foot oblong, truncated in front; with a conspicuous (aquiferous?) pore in the middle. Head produced. Tentacles far apart. Eyes on the tentacles. Gills 2. Lingual teeth (*uncini?*) in pairs, elongate, subulate, or hastate.

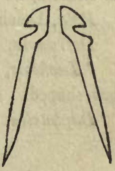
Fig. 72.*

CONUS, L. Cone-shell.

Types, C. marmoreus, pl. VII., fig. 1. C. geographicus, antediluvianus, &c.

Shell conical, tapering regularly; spire short, many-whirled; columella smooth, truncated in front; outer lip notched at the suture; operculum pointed, nucleus apical.

Distr., 269 sp. All tropical seas. Medit., 2; Africa, 23; Red Sea, 5; Asia, 124; Australia, 16; Pacific, 25; Gallapagos, 3; W. America, 20; W. Indies and Brazil, 21.

Fossil, 80 sp. Chalk—. Brit., France, India, &c.

The cones range northward as far as the Mediterranean, and southward to the Cape; but are most abundant and varied in equatorial seas. They inhabit fissures and holes of rocks, and the warm and shallow pools inside coral-reefs, ranging from low water to 30 and 40 fathoms; they move slowly, and sometimes (C. aulicus) bite when handled; they are all predatory. (Adams.)

Sub-genus. *Conorbis,* Sw. C. dormitor, Pl. VII., fig. 2. Eocene—. Brit., France.

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* **Fig. 72. Lingual teeth of bela turricula (after Lovén).**

PLEUROTOMA, Lam.

Etym., *pleura*, the side, and *toma*, a notch. *Syn.*, *turris*, Humph.

Types, P. Babylonica, Pl. VII., fig. 3. P. mitræformis, &c.

Shell fusiform, spire elevated; canal long and straight; outer lip with a deep slit near the suture. Operculum pointed, nucleus apical.

Distr., 430 sp. World-wide. Greenland, Brit., 17; Medit., 19; Africa, 15; Red Sea and India, 6; China, 90; Australia, 15; Pacific, 0? W. America, 52; W. Indies and Brazil, 20. The typical sp. about 20 (China, 16; W. America, 4.) Low water to 100 fathoms.

Fossil, 300 sp. Chalk—. Brit., France, &c. Chile.

Sub-genera. *Drillia*, Gray. D. umbilicata, canal short.

Clavatula, Lam., canal short, operc. pointed, nucleus in the middle of the inner edge. C. mitra, Pl. VII., fig. 4.

Tomella, Sw., canal long; inner lip callous near suture. T. lineata.

? *Clionella*, Gray. C. sinuata, Born sp. (= P. buccinoides) freshwaters, Africa.

Mangelia, Leach, (not Reeve). Apertural slit at the suture; no operc., M. tæniata, Pl. VII., fig. 5. Greenland, Brit., Medit.

Bela, Leach. Operc. nucleus apical. B. turricula, Pl. VII., fig. 6.

Defrancia, Millet,* no operc. D. linearis, Pl. VII., fig. 7.

? *Lachesis*, Risso, L. minima, Pl. VII., fig. 8, apex mammillated; operc. claw-shaped. Medit., S. Brit. In shallow water.

Daphnella, Hinds. D. marmorata. New Guinea. (Buc. junceum. L. clay).

FAMILY V. VOLUTIDÆ.

Shell turreted, or convolute; aperture notched in front; columella obliquely plaited. No operculum.

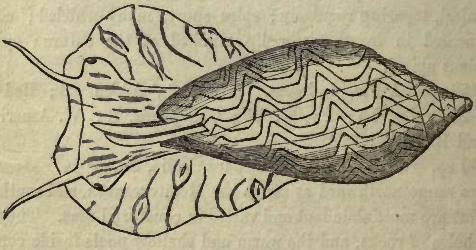

Fig. 73.†

Animal with a recurved siphon; foot very large partly hiding the shell;

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* According to Mr. S. Hanley, *Defrancia* is synonymous with *Mangelia*.

† Fig. 73. V. undulata, Lam. ½ Australia (from Quoy and Gaimard),

mantle often lobed and reflected over the shell; eyes on the tentacles, or near their base. Lingual ribbon linear; *rachis* toothed; *pleuræ* unarmed.

VOLUTA, L. Volute.

Type, V. musica, Pl. VII., fig. 9.

Syn., cymbiola, harpula, Sw. Volutella, D'Orb. Scapha, &c., Gray.

Shell ventricose, thick; spire short, apex mammillated; aperture large, deeply notched in front; columella with several plaits. V. musica and a few others have a small operculum.

Animal, eyes on lobes at the base of the tentacles; siphon with a lobe on each side, at its base; lingual teeth 3 cusped.

V. vespertilio and *hebræa* fill the nuclei of their spires with solid shell. *V. brasiliana* forms nidamental capsules 3 inches long. (D'Orb.) In *V. angulata* the mantle is produced into a lobe on the left side, and overlaps the shell.

Distr., 70 sp. W. Indies, Cape Horn, W. Africa, Australia, Java, Chili.

Fossil, 80 sp. Chalk—. India, Brit., France, &c.

Sub-genera. *Volutilithes*, Sw. Spire pointed, many-whirled, columella plaits indistinct. V. spinosus, Pl. VII., fig. 10.

Living, 1 sp. (*V. abyssicola*), dredged at 132 fathoms; off the Cape. (Adams).

Fossil, Eocene. Brit., Paris.

Scaphella, Sw. Fusiform, smooth.

Ex., V. magellanica. *Fossil*, V. Lamberti, Crag, Suffolk.

Melo, Brod. Large, oval; spire short.

Type, M. diadema, Pl. VII., fig. 11. New Guinea, 8 sp.

CYMBA, Broderip. Boat-shell.

Syn., Yetus (Adans.) Gray.

Type, C. proboscidalis, Pl. VII., fig. ·12, and fig. 74 (= V. cymbium, L.)

Shell like voluta; nucleus large and globular; whirls few, angular, forming a flat ledge round the nucleus.

The foot of the animal is very large, and deposits a thin enamel over the under side of the shell. It is ovo-viviparous, and the young animal is very large when born; the *nucleus* becomes partly concealed by the growth of the shell.

Distr., 10 sp. W. Africa, Lisbon.

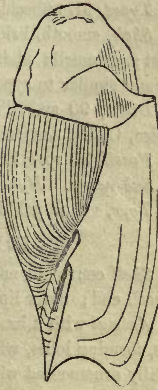

Fig. 74. *Cymba.*

MITRA, Lam. Mitre-shell.

Syn., turris, Montf. Zierliana, Gray. Tiara, Sw.

Types, M. episcopalis, Pl. VII., fig. 13. M. vulpecula, fig. 14.

Shell fusiform, thick; spire elevated, acute; aperture small, notched in front; columella obliquely plaited; operculum very small.

The animal has a very long proboscis; it emits a purple liquid, having a nauseous odour, when irritated. The eyes are placed on the tentacles, or at their base. Range, from low water to 15 fathoms, more rarely in 15—80 fathoms.

Distr., 350 sp. Philippines, India, Red Sea, Medit., W. Africa, Greenland (1 sp.), Pacific, W. America. The extra-tropical species are minute. M. Greenlandica and M. cornea (Medit. sp.) are found together in the latest British Tertiaries (Forbes.)

Fossil, 90 sp. Chalk—. India, Brit., France, &c.

Sub-genera. Imbricaria, Schum. (conœlix, Sw.)

Shell, cone-shaped. I. conica, Pl. VII., fig. 15.

Cylindra, Schum. (Mitrella, Sw.)

Shell, olive-shaped. C. crenulata, Pl. VII., fig. 16.

VOLVARIA, Lam.

Etym., volva, a wrapper.

Type, V. bulloïdes, Pl. VII., fig. 17.

Shell cylindrical, convolute; spire minute; aperture long and narrow; columella with 3 oblique plaits in front.

Fossil, 5 ? sp. Eocene. Brit., France.

MARGINÉLLA, Lam.

Etym., diminutive of *margo,* a rim.

Syn., porcellana (Adans.) Gray. Persicula, Schum.

Types, M. nubeculata, Pl. VII., fig. 18. M. persicula, fig. 19.

Shell, smooth, bright; spire short or concealed; aperture truncated in front; columella plaited; outer lip (of adult) with a thickened margin. *Animal* similar to cypræa.

Distr., 90 sp. Tropical, W. Indies, Brazil, Medit. (1 small sp.) W. Africa, China, Australia.

Fossil, 30 sp. Eocene—. France, &c.

Sub-genus. Hyalina, Schum. Outer lip scarcely thickened.

Type, voluta pallida, Mont., W. Indies.

FAMILY VI. CYPRÆIDÆ. Cowries.

Shell convolute, enamelled; spire concealed; aperture narrow, channelled at each end; outer lip (of adult) thickened, inflected. No operculum.

Animal with a broad foot, truncated in front; mantle expanded on each side, forming lobes, which meet over the back of the shell; these lobes are usually ornamented with tentacular filaments; eyes on the middle of the tentacles or near their base; branchial plume single. Lingual ribbon long, partly contained in the visceral cavity; *rachis* 1 toothed; *uncini* 3. The cowries inhabit shallow water, near shore, feeding on zoophytes.

CYPRÆA, L. Cowry.

Etym., Cypris, a name of Venus.

Types, C. tigris, C. mauritiana, Pl. VII., fig. 20.

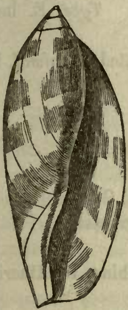

Fig. 75. *Cypræa, young.**

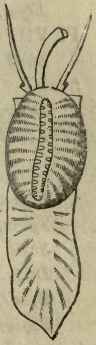

Fig. 76. *Trivia.*†

Shell ventricose, convolute, covered with shining enamel; spire concealed; aperture long and narrow, with a short canal at each end; inner lip crenulated; outer lip inflected and crenulated. (Lingual *uncini* similar).

The young shell has a thin and sharp outer lip, a prominent spire, and is covered with a thin epidermis, fig. 75. When full-grown the mantle lobes expand on each side, and deposit a shining enamel over the whole shell, by which the spire is entirely concealed. There is usually a line of paler colour which indicates where the mantle lobes met. *Cypræa annulus* is used by the Asiatic Islanders to adorn their dress, to weight their fishing-nets, and for barter. Specimens of it were found by Dr. Layard in the ruins of Nimroud. The money-cowrey (*C. moneta*) is also a native of the Pacific and Eastern seas; many tons weight of this little shell are annually imported into this country, and again exported for barter with the native tribes of Western Africa; in the year 1848 sixty tons of the money-cowry were imported into Liverpool; and in 1849 nearly three hundred tons were brought to the same place, according to the statement of Mr. Archer in the Industrial Exhibition. Mr. Adams observed the pteropodous fry of *C. annulus*, at Singapore, adhering in masses to the mantle of the parent, or swimming in rapid gyrations, or with abrupt jerking movements by means of their cephalic fins.

Distr., 150 sp. In all warm seas (except E. coast S. America?) but most abundant in those of the old world. On reefs and under rocks at low water.

Fossil, 78 sp. Chalk—. India, Brit., France, &c.

Sub-genera. Cyprovula, Gray. C. capensis, Pl. VII., fig. 21. Apertural plaits continued regularly over the margin of the canal.

Luponia, Gray. C. algoënsis, Pl. VII., fig. 22. Inner lip irregularly plaited in front.

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* Fig. 75. Cypræa testudinaria, L., young, China.

† Fig. 76. Trivia europæa, Mont. From the "British Mollusca," by Messrs. Forbes and Hanley.

Trivia, Gray. C. europæa, Pl. VII., fig. 23; fig. 76, and 15, B Small shells with striæ extending over the back. (*Uncini*; 1st denticulat 2, 3, simple.)

Distr., 30 sp. Greenland, Brit., W. Indies, Cape, Australia, Pacific, W America.

ERATO, Risso.

Etym., *Erato*, the muse of love-songs and mimicry. *Type*, E. lævis Pl. VII., fig. 24.

Shell minute; like *marginella*; lips minutely crenulated. *Animal*, lik *trivia*.

Distr., 8 sp. Brit., Medit., W. Indies, China.

Fossil, 2 sp. Miocene—. France, Brit. (Crag.)

OVULUM, Lam.

Etym., dimunitive of *ovum*, an egg. *Syn.*, amphiceras, Gronov.

Types, O. ovum, pl. VII., fig. 25. O. gibbosa and verrucosa.

Shell, like *cypræa*; inner lip smooth.

Distr., 36 sp. Warm seas. W. Indies, Brit., Medit. China, W. America

Fossil, 11 sp. Eocene—. France, &c.

Sub-genus, *calpurna*, Leach. O. volva ("The weaver's shuttle"). Aperture produced into a long canal at each end. Foot narrow, adapted fo walking on the round stems of the *gorgoniæ*, &c., on which it feeds. C patula inhabits the S. coast of Britain, it is very thin, and has a sharp oute lip.

SECTION B. HOLOSTOMATA. Sea-Snails.

Shell, spiral or limpet shaped; rarely tubular or multivalve: margin o the aperture entire. *Operculum*, horny or shelly, usually spiral.

Animal with a short non-retractile muzzle; respiratory siphon wanting, or formed by a lobe developed from the neck (fig. 61), gills pectinated o plume-like, placed obliquely across the back, or attached to the right side o the neck; neck and sides frequently ornamented with lappets and tentacula filaments. Marine or fresh-water. Mostly phytophagous.[*]

FAMILY I. NATICIDÆ.

Shell, globular, few-whirled; spire small, obtuse; aperture, semi-lunar lip, acute; pillar often callous.

Animal, with a long retractile proboscis; lingual ribbon linear; *rachis*, toothed; *uncini*, 3 (similar to *trivia*, fig. 15, B.); foot very large; mantle-lobe largely developed, hiding more or less of the shell. Species all marine.

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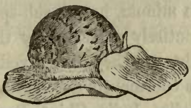
[*] These "sections" are not very satisfactory, but they are better than any othe yet proposed, and they are convenient, on account of the great extent of the orde *proso-branchiata*. *Natica* and *scalaria* have a retractile proboscis. *Pirena* has notched aperture, and *aporrhais*, a canal.

NATICA (Adans.), Lamarck.

Syn., mammilla, Schm. Cepatia, Gray. Nacca, Risso.
Type, N. canrena, Pl. VIII., fig. 1.



Shell, thick, smooth; inner lip callous; umbilicus large, with a spiral callus; epidermis thin, polished; operculum sub-spiral.

Animal blind; tentacles connate with a head veil; front of the large foot provided with a fold (*mentum*), reflected upon and protecting the head; operc. lobe large, covering part of the shell; jaws horny; lingual ribbon short; branchial plume single.

The coloured markings of the naticæ are very indestructible; they are frequently preserved on fossils. The *naticæ* frequent sandy and gravelly bottoms, ranging from low water to 90 fathoms (Forbes). They are carnivorous, feeding on the smaller bivalves (Gould), and are themselves devoured by the cod and haddock. Their eggs are agglutinated into a broad and short spiral band, very slightly attached, and resting free on the sands.

Distr., 90 sp. Arctic seas, Brit., Medit., Caspian, India, Australia, China, Panama, W. Indies.

Fossil, 260 sp. Devonian—. S. America, N. America, Europe, India.

Sub-genera, *naticopsis*, M'Coy. N. Phillipsii. Shell imperforate; inner lip very thick, spreading. Operc. shelly (Brit. Mus.). Carb. limestone, 7 sp.

Operculum, horny.

Neverita, Risso. N. Alderi. Fig. 77.

Lunatia, Gray. N. Ampullaria. Perforation simple; epidermis dull, olivaceous. Northern seas.

Globulus, J. Sby. (Deshayesia,† Raulin; Ampullina, Desh. not Bl.) N. Sigaretina. Pl. VIII., fig. 2. Umbilicus narrow (rimate), lined by a thin callus. *Fossil*, eocene. Brit., Paris.

Polinices, Montf., (naticella Guild.) N. mammilla. Shell oblong; callus very large, filling the umbilicus.

Cernina, Gray. N. fluctuata. Pl. VIII., fig. 3. Globular, imperforate; inner lip callous, covering part of the body whirl.

Naticella, Müller. 19 sp. *Fossil*, Trias, S. Cassian.

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* Fig. 77. Natica Alderi, Forbes. From an original drawing, communicated by Joshua Alder, Esq.

† *Deshayesia* was founded on a specimen with prominences on the pillar.

SIGARETUS (Adans.), Lamarck.

Syn., cryptostoma, Bl. Stomatia, Browne.

Type, S. haliotoïdes. Pl. VIII., fig. 4.

Shell, striated; ear-shaped; spire minute; aperture very wide, oblique (not pearly). Operculum minute, horny, sub-spiral.

The flat species are entirely concealed by the mantle when living; the convex shells only partially, and they have a yellowish epidermis. The anterior foot lobe (*mentum*) is enormously developed.

Distr., 26 sp. W. Indies, India, China, Peru.

Fossil, 10 sp. Eocene—. Brit., France, S. America.

Sub-genus, *naticina*, Gray. N. papilla, pl. VIII., fig. 3. Shell ventricose, thin, perforated. W. Indies, Red Sea, China, N. Australia, Tasmania. *Eocene*, Paris.

LAMELLARIA, Montagu.

Etym., *lamella*, a thin plate.

Syn., marsenia, Leach. Coriocella, Bl.

Type, L. perspicua. Pl. VIII., fig. 6.

Shell ear-shaped; thin, pellucid, fragile; spire very small; aperture large, patulous; inner lip receding. No operc.

Animal much larger than the shell, which is entirely concealed by the reflected margins of the mantle; mantle non-retractile, notched in front; eyes at the outer bases of the tentacles. Lingual *uncini* 3, similar; or one very large.

Distr., 5 sp. Norway, Brit., Medit., New Zealand, Philippines.

Fossil, 2 sp. Miocene—. Brit. (Crag.)

NARICA, Recluz.

Syn., vanicoro, Quoy. Merria, Gray. Leucotis, Sw.

Type, N. cancellata. Pl. VIII., fig. 8.

Shell thin, white, with a velvety epidermis; ribbed irregularly, and spirally striated; axis perforated. Operc. very small, thin.

Animal, eyes at the outer base of the tentacles; foot with wing-like lobes.

Distr., 6 sp. W. Indies, Nicobar, Vanikoro, Pacific.

Fossil, 4 sp. Gault— (D'Orb.) Brit., France.

VELUTINA, Fleming.

Etym., *velutinus*, velvety (from *vellus*, a fleece).

Type, V. lævigata. Pl. VIII., fig. 7.

Shell thin; with a velvety epidermis; spire small; suture deep; aperture very large, rounded; peristome continuous, thin. No operc.

Animal with a large oblong foot; margin of the mantle developed all round, and more or less reflected over the shell; gills 2; head broad; tentacles subulate, blunt, far apart; eyes on prominences at their outer bases. Carnivorous. Lingual dentition like trivia (fig. 15, B.).

Distr., 4 sp. Britain, Norway, N. America, Icy sea to Kamtschatka. Living on stones near low water, and ranging to 30 fms.

Fossil, 3 sp. Miocene—. Brit.

Sub-genus. *Otina* (Gray). V. otis. *Shell* minute, ear shaped. Animal like velutina, but with a simple mantle, and very short tentacles. W. and S. W. Brit. coast; inhabiting chinks of rocks, between tide-marks (Forbes).

FAMILY II. PYRAMIDELLIDÆ.

Shell spiral, turreted; nucleus minute, sinistral; aperture small; columella sometimes with one or more prominent plaits. *Operculum* horny, imbricated, nuclus internal.

Animal with broad ear-shaped tentacles, often connate; eyes behind the tentacles, at their bases; proboscis retractile; foot truncated in front; tongue unarmed. Species all marine.

Several genera of fossil shells are provisionally placed in this order, from their resemblance to *eulima* and *chemnitzia.** Tornatella, usually placed in or near this family, is *opistho-branchiate.*

PYRAMIDÉLLA, Lam.

Etym., dimunitive of *pyramis*, a pyramid.

Syn., obeliscus, Humph. (P. dolabrata. Pl. VIII., fig. 11.)

Type, P. auris-cati. Pl. VIII., fig. 10.

Shell slender, pointed, with numerous plaited or level whirls; apex sinistral; columella with several plaits; lip sometimes furrowed internally. Operc. indented on the inner side to adapt it to the columellar plaits. The shell of the typical pyramidellæ bears some resemblance to *cancellaria.*

Distr., 11 sp. W. Indies, Mauritius, Australia.

Fossil, 12 sp. Chalk ?—. France, Brit.

ODOSTOMIA, Fleming, 1824.

Etym., *odous*, a tooth, and *stoma*, mouth.

Type, O. plicata, Pl. VIII., fig. 12.

Shell subulate or ovate, smooth; apex sinistral; aperture ovate; peristome not continuous; columella with a single tooth-like fold; lip thin; operculum horny, indented on the inner side.

Distr., sp. Brit., Medit., Red Sea, Australia.

Fossil, 15 sp.? Eocene—. Brit., France.

Very minute and smooth shells, having the habit of *rissoæ*, and like them sometimes found in brackish water. They range from low water to 40 fms. The animal is undistinguishable from chemnitzia.

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* "The *Pyramidellidæ* present subjects of much interest to the student of extinct mollusca; numerous forms, bearing all the aspect of being members of this family, occur among the fossils of even the oldest stratified rocks. Many of them are gigantic compared with existing species, and the group, as a whole, may be regarded, rather as appertaining to past ages than the present epoch." (Forbes.)

CHEMNITZIA, D'Orbigny.

Etym., named in honour of Chemnitz, a distinguished conchologist of Nuremburg, who published seven volumes in continuation of Martini's "*Conchylien-Cabinet*," 1780-95.

Syn., turbonilla, Risso. Parthenia, Lowe. Pyramis and Jaminea, Br. Monoptigma, Gray. Amoura, Moller.

Type, C. elegantissima. Pl. VIII., fig. 13.

Shell slender, elongated, many-whirled; whirls plaited; apex sinistral; aperture simple; ovate; peristome incomplete; operculum horny, sub-spiral.

Animal, head very short, furnished with a long, retractile proboscis; tentacles triangular; eyes immersed at the inner angles of the tentacles; foot truncated in front, with a distinct *mentum*.

Distr., Brit. (4 sp.), Norway, Medit. Probably world-wide. Range from low water to 90 fms.

Fossil, 180 sp. Permian—. Brit., France, &c.

The "melaniæ" of the secondary rocks are provisionally referred to this genus. Those of the palæozoic strata to *loxonema*.

Sub-genus. Eulimella, Forbes. E. scillæ, Scacchi. 4 Brit. sp. Shell smooth and polished; columella simple; apex sinistral.

EULIMA, Risso, 1826.

Etym., *eulimia*, ravenous hunger. *Syn.*, pasithea, Lea.

Type, E. polita. Pl. VIII., fig. 14.

Shell small, white, and polished; slender, elongated, with numerous level whirls; obscurely marked on one side by a series of periodic mouths, which form prominent ribs internally; apex acute; aperture oval, pointed above; outer lip thickened internally; inner lip reflected over the pillar. Operculum horny, sub-spiral.

Animal, tentacles subulate, close, with the eyes immersed at their posterior bases; proboscis long, retractile; foot truncated in front, mentum bilobed; operc. lobe winged on each side; branchial plume single; mantle with a rudimentary siphonal fold.

The eulimæ creep with the foot much in advance of the head, which is usually concealed within the aperture, the tentacles only protruding. (Forbes.)

Distr., 15 sp. Brit., Medit., India, Australia, Pacific. In 5—90 fms. water.

Fossil, 40 sp. Carb. ?—. Brit., France, &c.

Sub-genus. Niso, Risso (=Bonellia, Desh.). N. terebellatus, Lam. sp. Axis perforated.

Fossil, 3 sp. Eocene —. Paris. *Distr.*, 5 sp. China, W. America (Cuming).

STYLINA, Fleming.

Ex., S. astericola. Pl. VIII., fig. 15. (Syn. stylifer, Brod.)

Shell, hyaline, globular or subulate, apex tapering, styliform, nucleus sinistral.

Animal with slender, cylindrical tentacles, and small sessile eyes at their outer bases; mantle thick, reflected over the last whirls of the shell; foot large, with a frontal lobe. Branchial plume single. Attached to the spines of sea-urchins, or immersed in living star fishes and corals.

Distr., 6 sp. W. Indies, Brit., Philippines, Gallapagos.

LOXONEMA, Phillips.

Etym., loxos, oblique, and *nema,* thread; in allusion to the striated surface of many species.

Shell elongated, many-whirled; aperture simple, attenuated above, effused below, with a sigmoidal edge to the outer lip.

Fossil, 75 sp. L. silurian—Trias. N. America, Europe.

MACROCHEILUS, Phillips.

Etym., macros, long, and *cheilos,* lip.

Shell, thick, ventricose, buccinoid; aperture simple, effuse below; outer lip thin, inner lip wanting, columella callous, slightly tortuous.

Type, M. arculatus, Schlotheim sp. Devonian. Eifel.

Fossil, 12 sp. Devonian—Carboniferous. Brit., Belgium.

FAMILY III. CERITHIADÆ. Cerites.

Shell spiral, elongated, many-whirled, frequently varicose; aperture channelled in front, with a less distinct posterior canal; lip generally expanded in the adult; operculum horny and spiral.

Animal with a short muzzle, not retractile; tentacles distant, slender; eyes on short pedicels, connate with the tentacles; mantle-margin with a rudimentary siphonal fold; tongue armed with a single series of median teeth, and three laterals or uncini; marine, estuary, or fresh-water.

CERITHIUM (Adans.). Bruguiere.

Etym., ceration, a small horn.

Type., C. nodulosum. Pl. VIII., fig. 16.

Shell turreted, many-whirled, with indistinct varices; aperture small, with a tortuous canal in front; outer lip expanded; inner lip thickened. Operculum horny, paucispiral. Pl. VIII., fig. 16*.

Distr., above 100 sp. World-wide, the typical species tropical. Norway, Brit., Medit., W. Indies, India, Australia, China, Pacific, Gallapagos.

Fossil. 460 sp. Trias—. Brit., France, U. States, &c.

Sub-genera. Rhinoclavis, Sw. C. vertagus. Canal long, bent abruptly operc., sub-spiral.

Bittium, Leach. C. reticulatum, Pl. VIII., fig. 17. Small northern species, ranging from low-water to 80 fathoms.

Triphoris, Deshayes. C. perversum, Pl. VIII., fig. 18. 30 sp. Norway—Australia. *Fossil.* Eocene—. Brit., France. Shell sinistral; anterior and posterior canals tubular. The third canal is only accidentally present, forming part of a varix.

Cerithiopsis, Forbes. C. tuberculare, Brit. Shell like *bittium;* proboscis retractile; operculum pointed, nucleus apical. Range 4—40 fms.

POTAMIDES, Brongniart. Fresh-water Cerites.

Etym., potamos, a river, and *eidos,* species.

Type., P. Lamarckii, Brong. (= Cerit. tuberculatum, Brard.)

Ex., P. mixtus. Pl. VIII., fig. 19.

Syn., tympanotomus, Klein, C. fuscatum, Africa. Pirenella, Risso, C. mammillatum, Pl. VIII., fig. 22.

Shell like cerithium, but without *varices,* in the very numerous typical fossil species; epidermis thick, olive-brown; operculum orbicular, many-whirled.

Distr., old world only? Africa, India. In the mud of the Indus they are mixed with sp. of ampullaria, venus, purpura, vulsella, &c. (Major W. E. Baker.)

Fossil (sp. included with cerithium) Eocene—. Europe.

Sub-genera. Cerithidea. Sw., C. decollata, Pl. VIII., fig. 24. Aperture rounded: lip expanded, flattened. Inhabit salt-marshes, mangrove swamps, and the mouths of rivers; they are so commonly out of the water as to have been taken for land-shells. Mr. Adams noticed them in the fresh-waters of the interior of Borneo, creeping on pontederia and sedges; they often suspend themselves by glutinous threads, fig. 78.

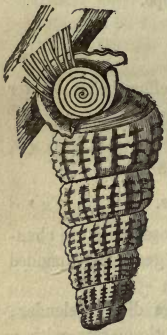
Fig. 78. *Cerithidea.**

Distr. India, Ceylon, Singapore, Borneo, Philippines, Port Essington.

Terebralia, Sw. Cerith, Telescopium, Pl. VIII., fig. 21.

Shell pyramidal; columella with a prominent fold, more or less continuous towards the apex; and a second, less distinct, on the basal front of the whirls (as in *nerinæa,* fig. 79). India, N. Australia.

T. telescopium is so abundant near Calcutta, as to be used for burning into lime; great heaps of it are first exposed to the sun, to kill the animals. They have been brought alive to England (Benson).

Pyrazus, Montf. Cerit, palustre, Pl. VIII., fig. 20.

Shell with numerous indistinct varices; canal straight, often tubular; outer lip expanded. India, N. Australia.

Cerith radulum and granulatum of the W. African rivers approach very nearly the fossil *potamides,* but they have numerous varices.

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* C. obtusa, Lam. sp. copied from Adams.

Lampania, Gray (batillaria, Cantor). Cerith, zonale. Pl. VIII., fig. 23. *Shell* without varices, canal straight. Chusan.

The fossil potamides decussatus, Brug., of the Paris basin, resembles this section, and retains its spiral red bands.

NERINÆA, Defrance.

Etym., *nereis,* a sea-nymph.

Ex., N. trachea. Fig. 79.

Shell elongated, many-whirled, nearly cylindrical; aperture channelled in front; interior with continuous ridges on the columella and whirls.

Fossil, 150 sp. Inf. oolite—U. chalk. Brit., France, Germany, Spain, and Portugal. They are most abundant, and attain the largest size to the south; and usually occur in calcarious strata, associated with shallow-water shells. (Sharpe.)

Sub-genera. 1. *Nerinæa.* Folds simple: 2—3 on the columella; 1—2 on the outer wall; columella solid, or perforated. Above 50 sp.

2. *Nerinella* (Sharpe), columella solid; folds simple; columellar, 0—1; outer wall 1.

3. *Trochalia* (Sharpe), columella perforated, with one fold; outer wall simple, or thickened, or with one fold; folds simple.

4. *Ptygmatis* (Sharpe), columella solid or perforated, usually with 3 folds; outer wall with 1—3 folds, some of them complicated in form.

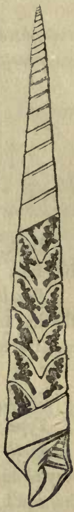

Fig. 79.*

? FASTIGIELLA, Reeve.

Type., F. carinata, Reeve.

Shell like turritella; aperture with a short canal in front (Mus., Cuming, and Brit. M.).

APORRHAIS, Aldrovandus.

Etym., aporrhais (Aristotle) "spout-shell" from aporrheo, to flow away.

Syn., chenopus Philippi.

Type, A. pes-pelecani. Pl. IV., fig. 7, and fig. 80.

Shell with an elongated spire; whirls numerous, tuberculated; aperture narrow, with a short canal in front; outer lip of the adult expanded and lobed or digitated; operc. pointed, lamellar.

Animal with a short broad muzzle; tentacles cylindrical, bearing the eyes on prominences near their bases, outside; foot short, angular in front;

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[*] Fig. 79. Nerinæa trachea, Desl., partly ground down to shew the form of the interior. Bath oolite, Ranville. Communicated by John Morris, Esq.

branchial plume single, long; lingual ribbon linear; teeth single, hooked, denticulated; uncini 3, the first transverse, 2 and 3 claw-shaped.

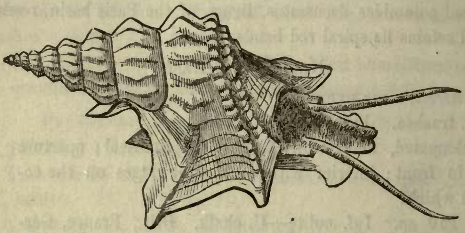

Fig. 80.*

Distr., 3 sp. Labrador, Norway, Brit., Medit. W. Africa. Range,—100 fms.

Fossil; see Pteroceras and Rostellaria; above 200 species, ranging from the lias to the chalk, probably belong to this genus, or to genera not yet constituted.

STRUTHIOLARIA, Lam.

Etym., *struthio*, an ostrich (-foot), from the form of its aperture.

Type, S. straminea, Pl. IV., fig. 6.

Shell turreted; whirls angular; aperture truncated in front; columella very oblique; outer lip prominent in the middle, reflected and thickened in the adult; inner lip callous, expanded; operculum claw-shaped, curved inwards, with a projection from the outer, concave edge.

Animal with an elongated muzzle? tentacles cylindrical; eye-pedicels short, adnate with the tentacles, externally; foot broad and short. (Kiener.)

Distr., 5 sp. Australia and New Zealand; where alone it occurs subfossil.

FAMILY IV. MELANIADÆ.

Shell spiral, turreted; with a thick, dark epidermis; aperture often channelled, or notched in front; outer lip acute; operculum horny, spiral. The spire is often extensively croded by the acidity of the water in which the animals live.

Animal with a broad non-retractile muzzle; tentacles distant, subulate; eyes on short stalks, united to the outer sides of the tentacles; foot broad and short, angulated in front; mantle-margin fringed; tongue long and linear, with a median and 3 lateral series of hooked multi-cuspid teeth. Often viviparous. Inhabiting fresh-water lakes and rivers throughout the warmer parts of the world. Only fossil in Britain.

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* Fig. 80. Aporrhais pes-pelecani, L., from a drawing by Joshua Alder, Esq., n the "British Mollusca."

MELANIA, Lam.

Etym., *Melania*, blackness (from *melas*).

Type, M. amarula. Pl. VIII., fig. 25.

Syn. Thiara, Megerle. Pyrgula, Crist.

Shell turreted, apex acute (unless eroded); whirls ornamented with striæ or spines; aperture oval, pointed above: outer lip sharp, sinuous; operculum subspiral. Pl. VIII., fig. 25*.

Distr., 160 sp. S. Europe, India, Philippines, Pacific Islands. Distinct groups in the southern states of N. America.

Fossil, 25 sp. Eocene—. Europe (v. *chemnitzia*).

Sub-genera. Melanàtria, Bowdich. M. fluminea* Pl. VIII., fig. 26. Aperture somewhat produced in front; operculum with rather numerous whirls. This section includes some of the largest sp. of the genus, and is well typified by the fossil, M. Sowerbii (cerit. melanoides, Sby.) of the Woolwich sands. Old World, India, Philippines.

Vibex, Oken, V. fuscatus, Pl. VIII., fig. 29. V. auritus. W. Africa. Whirls spirally ridged, or muricated; aperture broadly channelled in front.

Ceriphasia, Sw., C. sulcata. N. America. Aperture like vibex; slightly notched near the suture.

Hemisinus, Sw., H. lineolatus. W. Indies. Aperture channelled in front.

Melafùsus, Sw. (Io, Lea. Glottella, Gray.) M. fluviatilis. Pl. VIII., fig. 27. U. States. Aperture produced into a spout in front.

Melàtoma, Anthony (not Sw.) M. altilis. Shell like anculotus; with a deep slit at the suture. U. States.

Anculotus, Say. A. præmorsus. Pl. VIII., fig. 28. Shell globular; spire very short; outer lip produced. U. States.

Amnicola, Anthony. A. isogona. Pl. IX., fig. 23. U. States.

? Pachystoma, Gray. M. marginata, Eocene. Paris. Peristome thickened externally, all round.

PALUDOMUS, Swainson.

Etym., *palus*, a marsh, and *domus*, home.

Syn., tanalia, Gray. Hemimitra, Sw.

Type, P. aculeatus, Gm. sp. Pl. IX., fig. 34.

Shell, turbinated, smooth or muricated; with wavy stains beneath the olive epidermis; spire small, usually eroded; operc. horny, lamellar, nucleus external. Animal like melania; mantle-margin fringed (Eydoux).

Distr., 10 sp. Ceylon (Himalaya ?) in the mountain-streams, sometimes at an elevation of 6,000 feet. The Himalayan sp. (*melania conica*, Gray,

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* This is a good section of *melania*, but Mr. Gray's type does not well represent it, being more like a pirena in the form of its aperture.

hemimitra retusa, Sw., and several others), referred to this genus, have a concentric operculum, like *paludina.*

MELANÓPSIS, Lam.

Types, M. buccinoides, M. costata. Pl. VIII., fig. 30.

Shell ; body-whirl elongated; spire short and pointed; aperture distinctly notched in front; inner lip callous; operculum sub-spiral.

Distr., 20 sp. Spain, Asia Minor, New Zealand.

Fossil, 25 sp. Eocene—. Europe.

Sub-genus. Pirēna, Lam. (faunus, Montf.) P. atra. Pl. VIII., fig. 31. Spire elongated, many whirled; outer lip of the adult produced.

Distr., 4 sp. ? S. Africa, Madagascar, Ceylon, Philippines.

FAMILY V. TURRITELLIDÆ.

Shell tubular, or spiral; upper part partitioned off; aperture simple; operculum horny, many-whirled.

Animal with a short muzzle; eyes immersed, at the outer bases of the tentacles; mantle-margin fringed; foot very short; branchial plume single; tongue armed.

TURRITÉLLA, Lam.

Etym., diminutive of *turris,* a tower.

Syn., terebellum, torcula, zaria and eglisia, Gray.

Type, T. imbricata. Pl. IX., fig. 1.

Shell elongated, many-whirled, spirally striated; aperture rounded, margin thin; operculum horny, many-whirled; with a fimbriated margin.

Animal with long, subulate tentacles; eyes slightly prominent; foot truncated in front, rounded behind, grooved beneath; branchial plume very long; lingual ribbon minute; median teeth hooked, denticulated; uncini 3, serrulated. Carnivorous ?

Distr., 50 sp. World-wide. Ranging from the Laminarian Zone to 100 fms. W. Indies, U. States, Brit. (1 sp.), Iceland, Medit., W. Africa, China, Australia, W. America.

Fossil, 170 sp., Neocomian—. Brit. &c., S. America, Australia.

Sub-genera. Proto, Defr., P. cathedralis, Pl. IX., fig. 3, aperture truncated below.

Mesalia, Gray, M. sulcata (var.) Pl. IX., fig. 2. Greenland—S. Africa. *Fossil,* Eocene. Brit., France.

? ACLIS, Lovén.

Etym., A, without, *kleis,* a projection.

Syn., alvania, Leach (not Risso).

Type, A. perforatus, Mont. Pl. IX., fig. 4.

Shell minute, like turritella; spirally striated; aperture oval; outer lip prominent; axis slightly rimate; operculate.

Animal with a long retractile proboscis; tentacles close together, slender, inflated at the tips; eyes immersed at the bases of the tentacles; operc. lobe ample, unsymmetrical; foot truncated in front. Ranges to 80 fathoms water. 3 Brit. sp. Norway.

Fossil. ? sp., Miocene—. Brit. (Crag).

CÆCUM, Fleming.

Syn., corniculina, Münster. Brochus, Bronn. Odontidium, Phil.

Type, C. trachea, Pl. IX, fig. 5. Young sp., fig. 6.

Shell at first discoidal, becoming decollated when adult; tubular, cylindrical, arched; aperture round, entire; apex closed by a mammillated septum. Operc. horny, many-whirled. Lingual teeth, 0; uncini, 2, the inner broad and serrulated.

Distr., Brit., 2 sp., 10 fathoms. Medit.

Fossil, 4 sp. Eocene—. Brit., Castelarquato.

VERMETUS, Adanson. Worm-shell.

Syn., siphonium, Gray. Serpuloides, Sassi.

Types, V. lumbricalis, Pl. IX., fig. 7.

Shell tubular, attached; sometimes regularly spiral when young; always irregular in its adult growth; tube repeatedly partitioned off; aperture round; operc. circular, concave externally.

Distr., Portugal, Medit., Africa, India.

Fossil, 12 sp. Neocomian—. Brit., France, &c.

? Sub-genus. Spiroglyphus, Daud. S. spirorbis Dillw. sp., irregularly tubular; attached to other shells, and half buried in a furrow which it makes as it grows. Perhaps an annelide?

SILIQUARIA, Brug.

Etym., *siliqua*, a pod.

Type, S. anguina, Pl. IX., fig. 8.

Shell tubular; spiral at first, irregular afterwards; tube with a continuous longitudinal slit.

Distr., 7 sp. Medit., N. Australia. Found in sponges.

Fossil, 10 sp. Eocene—. France, &c.

SCALARIA, Lam. Wentle-trap.

Etym., *scalaris*, like a ladder. *Type*, S. pretiosa, Pl. IX., fig. 9 (= T. scalaris, L.)

Shell, mostly pure white and lustrous; turreted; many-whirled; whirls round, sometimes separate, ornamented with numerous transverse ribs; aperture round; peristome continuous. Operc. horny, few-whirled.

Animal with a retractile proboscis-like mouth; tentacles close together, long and pointed, with the eyes near their outer bases; mantle-margin simple, with a rudimentary siphonal fold; foot obtusely triangular, with a fold (*mentum*) in front. Lingual dentition nearly as in *bulla;* teeth 0; *uncini* numerous, simple; sexes distinct; predacious? Range from low water to 80 fathoms. The animal exudes a purple fluid when molested.

Distr., nearly 100 sp. Mostly tropical. Greenland, Norway, Brit., Medit., W. Indies, China, Australia, Pacific, W. America.

Fossil, nearly 100 sp. Coral-rag—. Brit., N. America, Chile, India.

FAMILY VI. LITORINIDÆ.

Shell spiral, turbinated or depressed, never pearly; aperture rounded; peristome entire; operculum horny, pauci-spiral.

Animal with a muzzle-shaped head, and eyes sessile at the outer bases of the tentacles; tongue long, armed with a median series of broad, hooked teeth, and 3 oblong, hooked uncini. Branchial plume single. Foot with a linear duplication in front, and a groove along the sole. Mantle with a rudimentary siphonal canal; operc. lobe appendaged.

The species inhabit the sea, or brackish water, and are mostly litoral, feeding on algæ.

LITORINA, Férussac. Periwinkle.

Etym., *litus,* the sea-shore.

Type, L. litorea, Pl. IX., fig. 10.

Shell turbinated, thick, pointed, few-whirled; aperture rounded, outer lip acute, columella rather flattened, imperforate, operculum pauci-spiral, fig. 81. Lingual teeth hooked and trilobed; uncini hooked and dentated.

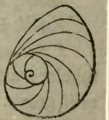

Fig. 81.

Distr., 40 sp. The periwinkles are found on the sea-shore, in all parts of the world. In the Baltic they live within the influence of fresh-water, and frequently become distorted; similar monstrosities are found in the Norwich crag.

The common sp. (*L. litorea*) is oviparous; it inhabits the lowest zones of sea-weed between tide-marks. An allied sp. (*L. rudis*) frequents a higher region, where it is scarcely reached by the tide; it is viviparous, and the young have a hard shell before their birth, in consequence of which the species is not eaten. The tongue of the periwinkle is two inches long; its foot is divided by a longitudinal line, and in walking the sides advance alternately. The periwinkle and trochus are the food of the thrush, in the Hebrides, during winter.

Fossil, 10 sp? Miocene—. Brit., &c. It is probable that a large proportion of the oolite and cretaceous shells referred to *turbo,* belong to this genus, and especially to the section *tectaria.*

Sub-genera. Tectaria, Cuvier, 1817 (= Pagodella, Sw.) L. pagodus, Pl. IX., fig. 11. Shell muricated or granulated; sometimes with an umbilical fissure. Operc. with a broad, membranous border. W. Indies, Zanzibar, Pacific.

Modulus, Gray (and nina, Gray) M. tectum, Pl. IX., fig. 13. Shell trochiform or naticoid; porcellanous; columella perforated; inner lip worn or toothed; operc. horny, ~~many~~-whirled. *Distr.*, Philippines, W. America.

Fossarus (Adans.) Philippi. F. sulcatus, Pl. IX., fig. 12. *Syn.*, phasianema, Wood. Shell perforated; inner lip thin; operc. not spiral. *Distr.*, Medit. *Fossil*, 3 sp. Miocene—. Brit., Medit.

Risella, Gray. Lit., melanostoma, Pl. IX., fig. 14. Shell trochiform, with a flat or concave base; whirls keeled; aperture rhombic, dark or variegated, operc. pauci-spiral. Distr., N. Zealand.

SOLARIUM, Lam. Stair-case shell.

Etym., *solarium*, a dial.

Syn., architectoma, Bolten. Philippia, Gray. Helicocryptus, D'Orb?

Type., S. perspectivum, Pl. IX., fig. 15.

Shell orbicular, depressed; umbilicus wide and deep; aperture rhombic; peristome thin; operculum horny, sub-spiral.

The spiral edges of the whirls, seen in the umbilicus, have been fancifully compared to a winding stair-case.

Distr., 25 sp. Tropical seas. Medit., E. Africa, India, China, Japan, Australia, Pacific, W. America.

Fossil, 56 sp. Eocene—. Brit., &c. 26 other sp. (oolites—chalk,) are provisionally referred to this genus; the cretaceous sp. are *nacreous* (v. trochus).

Sub-genera. *Torinia*, Gray. T. cylindracea, operc. conical, multi-spiral, with projecting edges, fig. 82. Living, New Ireland. *Fossil*, Eocene. Brit. Paris.

Omalaxis, Desh. (altered to *bifrontia*) S. bifrons, discoidal, the last whirl disengaged. 6 sp. Eocene, Paris, Brit.

? Orbis, Lea. Discoidal, whirls quadrate. *Fossil*, Eocene, America.

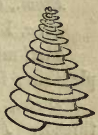
Fig. 82.*

? PHORUS, Montf. Carrier-shell.

Etym., *phoreus*, a carrier.

Syn., onustus, Humph., Xenophorus, Fischer.

Examples, P. conchyliophorus, Born. P. corrugatus, Pl. X., fig. 1.

Shell trochiform, concave beneath; whirls flat, with foliaceous or stellated margins, to which shells, stones, &c., are usually affixed; aperture very oblique, not pearly; outer lip thin, much produced above, receding far beneath. Operc. horny, imbricated, nucleus external (as in *purpura* and *paludomus*,) with the transverse scar seen through it, fig. 83. (Mus. Cuming.)

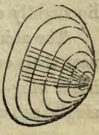
Fig. 83.

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* Operculum of S. patulum, Lam. $\frac{3}{1}$, from Deshayes.

Animal with an elongated (non-retractile ?) proboscis; tentacles long and slender, with sessile eyes at their outer bases; sides plain; foot narrow, elongated behind. (Adams.) Related to *scalaria ?*

Most of the phori attach foreign substances to the margins of their shells, as they grow; particular species affecting stones, whilst others prefer shells or corals. They are called "mineralogists," and "conchologists," by collectors; P. solaris and P. indicus are nearly or quite free from these disguises. They are said to frequent rough bottoms, and to scramble over the ground, like the strombs, rather than glide evenly.

Distr., 9 sp. W. Indies, India, Malacca, Philippines, China, W. America.

Fossil, 15 sp. Chalk ?—Eocene—. Brit., France. Shells extremely like the recent *phorus*, are met with even in the carb. limestone.

LACUNA, Turton.

Etym., *lacuna*, a fissure.

Type, L. pallidula, Pl. IX., fig. 16. *Syn.*, medoria, Gray.

Shell, turbinated, thin; aperture semi-lunar; columella flattened, with an umbilical fissure. Operc. pauci-spiral.

Animal, operculigerous lobe furnished with lateral wings and tentacular filaments. Teeth, 5 cusped; uncini 1, 2 dentated, 3 simple. Spawn (*ootheca*) vermiform, thick, semicircular. Range, low-water—50 fathoms.

Distr., Northern shores, Norway, Brit., Spain. *Fossil*, 1 sp. Glacial beds, Scotland.

? LITIOPA, Rang.

Etym., *litos*, simple, *ope*, aperture.

Type, L. bombix. Pl. IX., fig. 24.

Shell minute, pointed; aperture slightly notched in front; outer lip simple, thin; inner lip reflected. Operc. spiral.

Distr., Atlantic, Medit., on floating sea-weed, to which they adhere by threads. *Fossil*, 1 sp. Miocene (Crag.).

RISSOA, Frémenville.

Etym., named after Risso,* a French zoologist.

Type, R. labiosa, Pl. IX., fig. 17. *Syn.*, cingula, Flem.

Shell minute, white or horny; conical, pointed, many-whirled; smooth, ribbed, or cancellated; aperture rounded; peristome entire, continuous; outer lip slightly expanded and thickened. Operc. sub-spiral.

The animal has long, slender tentacles, with eyes on small prominences near their outer bases; the foot is pointed behind; the operculigerous lobe has a wing-like process and a filament (*cirrus*) on each side. Lingual teeth single, sub-quadrate, hooked, dentated; uncini 3; 1 dentated, 2, 3, claw-shaped. They range from high-water to 100 fathoms, but abound most in shallow water, near shore, on beds of *fucus* and *zostera.*

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* It is much to be regretted that some modern naturalists have tried to find out and bring into use the obscure genera of Risso, and the worthless fabrications of Montfort and Rafinesque, which had better have remained unknown.

Distr., about 70 sp. Universally distributed, but most abundant in the north temperate zone. N. America, W. Indies, Norway, Brit., Medit., Caspian, India, &c. *Rissoa parva* adheres to sea-weeds, by threads, like litiopa (Gray).

Fossil, 100 sp. Permian—. Brit., France, &c.

Sub-genera. Rissoina, D'Orb. Aperture channelled in front. Living and Fossil (10 sp. Bath oolite.— Brit.) = *Tuba,* Lea? America.

Hydrobia, Hartm. (=Paludinella, Lovén. Paludestrina, D'Orb.) *Shell* smooth; foot rounded behind; operc. lobe without filament. *Type,* litorina ulvæ, Pl. IX., fig. 18. *Fossil,* 10 sp. Wealden—. Brit., &c.

Syncera, Gray (Assiminea, Leach). S. hepatica. *Shell* like Hydrobia; tentacles connate with the eye pedicels, which equal them in length. Teeth 5—7 cusped; uncini 1, 2, dentated, 3 rounded. *Distr.*, brackish water. Brit., India.

Nematura, Benson. N. deltæ. Pl. IX., fig. 21. Aperture contracted; peristome entire. Operc. pauci-spiral. *Fossil,* eocene. Isle of Wight.

Jeffreysia, Alder (=Rissoëlla, Gray, MS.), J. diaphana. Shell minute, translucent. Operc. semilunar, imbricated, with a projection from the straight, inner side. (Pl. IX., fig. 19.) Head elongated, deeply cleft, and produced into two tentacular processes; mouth armed with denticulated jaws, and a spinous tongue; tentacles linear, eyes far behind, prominent, only visible through the shell; foot bi-lobed in front. 2 sp. Brit. On sea-weed, near low water (Alder).

SKENEA, Fleming.

Etym., named after Dr. Skene of Aberdeen; a cotemporary of Linnæus.

Syn., delphinoïdea, Brown.

Type, S. planorbis, Pl. IX., fig. 20.

Shell minute orbicular, depressed, few-whirled; peristome continuous, entire, round. Operc. pauci-spiral. Animal like rissoa, foot rounded behind. Found under stones at low-water, and amongst the roots of *corallina officinalis.*

Distr., ? sp. Northern seas. Norway, Brit.

? TRUNCATELLA, Risso. Looping-snail.

Type, T. truncatula. Pl. IX., fig. 25. (Mus., Hanley.)

Shell minute, cylindrical, truncated; whirls striated transversely; aperture oval, entire; peristome continuous. Operculum sub-spiral!

Animal with short, diverging triangular tentacles; eyes centrally behind; head bi-lobed; foot short, rounded at each end (Forbes).

The truncatellæ are found on stones and sea-weeds between tide-marks, and survive many weeks out of the water (Lowe). They walk by contracting the space between their lips and foot, like the geometric caterpillars (Gray). They are found semi-fossil, along with the human skeletons in the modern limestone of Guadaloupe.

Distr., 15 sp. W. Indies, Brit., Medit., Rio, Cape, Mauritius, Philippines, Australia, Pacific (Cuming).

? LITHOGLYPHUS, Megerle.

Type, L. fuscus. Pl. IX., fig. 22.

Shell naticoid, often eroded; whirls few, smooth; aperture large, entire; peristome continuous, outer lip sharp, inner lip callous; umbilicus rimate; epidermis olivaceous; operculum pauci-spiral.

Distr., sp. Europe, Oregon.

FAMILY VII. PALUDINIDÆ.

Shell conical or globular, with a thick, olive-green epidermis; aperture rounded; peristome continuous, entire; operculum horny or shelly, normally concentric.

Animal with a broad muzzle; tentacles long and slender; eyes on short pedicels, outside the tentacles. Inhabiting fresh-waters in all parts of the world.

PALUDINA, Lam. River-snail.

Etym., *palus* (paludis) a marsh. *Syn.*, viviparus, Gray.

Type, P. Listeri. Pl. IX., fig. 26. (P. vivipara, fig. 61.)

Shell turbinated, with round whirls; aperture slightly angular behind; peristome continuous, entire; operc. horny, concentric. *Animal* with a long muzzle, and very short eye-pedicels; neck with a small lappet on the left side, and a larger on the right, folded to form a respiratory siphon; gill comb-like, single; tongue short; teeth single, oval, slightly hooked and denticulated; uncini 3, oblong, denticulated. The paludinæ are viviparous; the shells of the young are ornamented with spiral rows of epidermal cirri.

Distr., 60 sp. Rivers and lakes throughout the N. hemisphere; Black sea, Caspian.

Fossil, 50 sp. Weald—. Brit., &c.

Sub-genus. Bithinia (Prideaux), Gray. B. tentaculata, Pl. IX., fig. 27. Shell small; operc. shelly. Animal oviparous; with only one neck-lappet, on the right side. The bithiniæ oviposit on stones and aquatic plants; the female lays from 30 to 70 eggs in a band of three rows, cleaning the surface as she proceeds; the young are hatched in three or four weeks, and attain their full growth in the second year (Bouchard).

AMPULLARIA, Lam. Apple-snail, or idol-shell.

Etym., *ampulla*, a globular flask.

Ex., A. globosa, Pl. IX., fig. 30. *Syn.*, pachylabra, Sw.

Shell globular, with a small spire, and a large ventricose body-whirl; peristome thickened and slightly reflected. Operc. shelly.

Animal with a long incurrent siphon, formed by the left neck-lappet; left gill developed, but much smaller than the right*; muzzle produced into two long tentacular processes; tentacles extremely elongated, slender. Inhabits lakes and rivers throughout the warmer parts of the world, retiring deep into the mud in the dry season, and capable of surviving a drought, or removal from the water for many years. In the lake Mareotis, and at the mouth of the Indus, ampullariæ are abundant, mixed with marine shells. Their eggs are large, inclosed in capsules, and aggregated in globular masses.

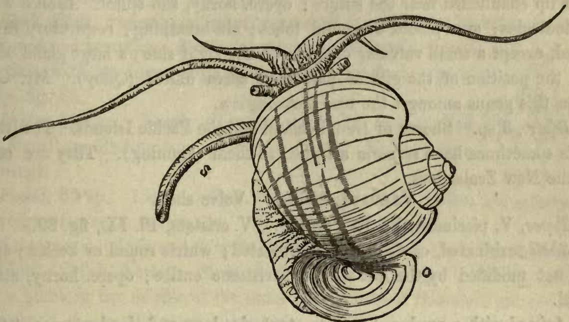

Fig. 84.†

Distr., 50 sp. S. America, West Indies, Africa, India.

Sub-genera. Pomus, Humph. A. ampullacea. Operc. horny.

Marisa, Gray (ceratodes, Guilding). A. cornu-arietis Pl. IX., fig. 31. Operc. horny. Shell discoidal.

Asolene, D'Orb. A. platæ. Animal without a respiratory siphon; operc. shelly. Distr., S. America.

Lanistes, Montf. A. bolteniana, L., Pl. IX., fig. 32. Shell reversed, umbilicated, peristome thin; operc. horny. Distr., W. Africa, Zanzibar, Nile.

Meladomus, Sw. Paludina olivacea, Sby. Shell reversed, imperforate; peristome thin; operc. horny.

? AMPHIBOLA, Schumacher.

Syn., ampullacera, Quoy. Thallicera, Sw.

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* The ampullaria is said to have a pulmonic sac in addition to its gills (Gray, Owen), but we have not met with specimens sufficiently well preserved to exhibit it. would be very desirable to examine the amp. cornu-arietis, in which, probably, the gills are symmetrical, as in the cephalopods.

† Fig. 84. Ampullaria canaliculata, Lam. (from D'Orb.) South America. The branchial siphon (*s*) is seen projecting from the left side; *o*, operculum

Type, A. australis, Pl. IX., fig. 33.

Shell globular, with an uneven, battered, surface; columella fissured; outer lip channelled near the suture; operc. horny, sub-spiral. *Animal* without tentacles; eyes placed on round lobes; air-breathing; respiratory cavity closed, except a small valvular opening on the right side; a large gland occupies the position of the gill of paludina; sexes united (Quoy). Mr. Gray places this genus amongst the true *pulmonifera.*

Distr., 3 sp. Shores of New Zealand and the Pacific Islands. The living shells sometimes have *serpulæ* attached to them (Cuming). They are eaten by the New Zealanders.

VALVATA, Müller. Valve-shell.

Types, V. piscinalis, Pl. IX., fig. 28. V. cristata, Pl. IX., fig. 29.

Shell turbinated, or discoidal, umbilicated; whirls round or keeled; aperture not modified by the last whirl; peristome entire; operc. horny, multispiral.

Animal with a produced muzzle; tentacles long and slender, eyes at their outer bases; foot bi-lobed in front; branchial plume long, pectinated, partially exserted on the right side, when the animal is walking. Lingual teeth broad; uncini 3, lanceolate; all hooked and denticulated.

Distr., 6 sp. Brit., N. America.

Fossil, 19 sp. Wealden—. Brit., Belgium, &c.

FAMILY VIII. NERITIDÆ.

Shell thick, semi-globose; spire very small; cavity simple, from the absorption of the internal portions of the whirls; aperture semi-lunate; columellar side expanded and flattened; outer lip acute. Operculum shelly, subspiral, articulated.

At each end of the columella there is an oblong muscular impression, connected on the outer side by a ridge, on which the operculum rests; within this ridge the inner layers of the shell are absorbed.

Animal with a broad, short muzzle, and long slender tentacles; eyes on prominent pedicels, at the outer bases of the tentacles; foot oblong, triangular. Lingual dentition similar to the *turbinidæ.* Teeth 7; uncini very numerous.

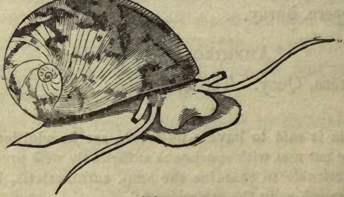

Fig. 85.*

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* Fig. 85. Nerita polita, L. (from Quoy and Gaimard) New Ireland.

NERITA, L. Nerite.

Etym. *Nerites,* a sea-snail, from nereïs.

Type, N. ustulata, Pl. IX., fig. 35.

Shell thick, smooth or spirally grooved; epidermis horny; outer lip thickened and sometimes denticulated within; columella broad and flat, with its inner edge straight and toothed; operc. shelly, fig. 86.

Distr., 116 sp. Nearly all warm seas. W. Indies, Red Sea, Zanzibar, Philippines, Australia, Pacific, W. America, (Cuming).

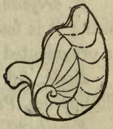

Fig. 86.*

Fossil, 60 sp. Lias—. Brit. &c. The palæozoic nerites are referred by D'Orbigny to *turbo, natica,* &c. N. haliotis is a *pileopsis.*

Sub-genera. *Neritoma,* Morris, 1849. N. sinuosa, Sby. Portland stone, Swindon. (Mus., Lowe). Shell ventricose, thick; apex eroded; aperture with a notch in the middle of the outer lip. Casts of this shell are common, and exhibit the condition of the interior characteristic of all the *nerites;* it was probably fresh-water.

Neritopsis, Grateloup. N. radula, Pl. VIII., fig. 9. Shell like *nerita;* inner lip with a single notch in the centre.

Distr., 1 sp. Pacific. *Fossil,* 20 sp. Trias ? Brit., France, &c.

Velates, Montf. N. perversa, Gm. Pl. IX., fig. 36. Inner lip very thick and callous; outer lip prolonged behind, and partially enveloping the spire.

PILEOLUS, (Cookson) J. Sowerby.

Etym., pileolus, a little cap.

Type, P. plicatus, Pl. IX., fig. 37, 38.

Shell limpet-like above, with a sub-central apex; concave beneath, with a small semi-lunar aperture, and a columellar disk, surrounded by a broad continuous peristome.

Distr., marine; only known as fossils of the Bath oolite, Ancliffe, and Minchinhampton, 3 sp. *P. neritoides* is a neritina.

NERITINA, Lam. Fresh-water nerite.

Examples, N. zebra, Pl. IX., fig. 39. N. crepidularia, Pl. IX., fig. 40.

Shell rather thick at the aperture, but extensively absorbed inside; outer lip acute; inner straight denticulated; operc. shelly, with a flexible border; slightly toothed on its straight edge.

Animal like *nerita;* lingual teeth;—median, minute; laterals 3, 1 large, sub-triangular, 2, 3, minute; uncini about 60, first very large, hooked, denticulated; the rest equal, narrow, hooked, denticulated.

The neritinæ are small globular shells, ornamented with a great variety of black or purple bands and spots, covered with a polished horny epidermis

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* Fig. 86. Operculum of N. peloronta. W. Indies.

They are mostly confined to the fresh waters of warm regions. One sp. (N fluviatilis) is found in Brit. rivers, and in the brackish water of the Baltic Another extends its range into the brackish waters of the N. American rivers And the West Indian *N. viridis* and *meleagris*, are found in the sea.

N. crepidularia has a continuous peristome, and approaches *navicella* i form; it is found in the brackish waters of India. N. corona (Madagascar is ornamented with a series of long tubular spines.

Distr., 76 sp. W. Indies, Norway, Brit., Black Sea, Caspian, India Philippines, Pacific, W. America.

Fossil, 20 sp. Eocene—. Brit., France. &c.

NAVICELLA, Lam.

Etym., *navicella*, a small boat. *Type*, N. porcellana. Pl. IX., fig. 41.

Shell oblong, smooth, limpet-like; with a posterior, sub-marginal apex aperture as large as the shell, with a small columellar shelf, and elongate lateral muscular scars; operculum very small, shelly.

Distr., 18 sp. India, Mauritius, Moluccas, Australia, Pacific.

FAMILY IX., TURBINIDÆ.

Shell spiral, turbinated or pyramidal, nacreous inside; operculum calcarious and pauci-spiral, or horny and multi-spiral.

Animal with a short muzzle; eyes pedunculated at the outer bases of th long and slender tentacles; head and sides ornamented with fringed lobes an tentacular filaments (*cirri*); branchial plume single; lingual ribbon long an linear, chiefly contained in the visceral cavity; median teeth broad; lateral 5, denticulated; uncini very numerous (sometimes nearly 100), slender, wit hooked points (Fig. 15, A.).

Marine, feeding on sea-weeds (*algæ*).

The shells of nearly all the turbinidæ are brilliantly pearly, when th epidermis and outer layer of shell are removed; many of them are used in th state for ornamental purposes.

TURBO, L. Top-shell.

Etym., *turbo*, a whipping-top.

Syn., batillus, marmorostoma, callopoma, &c. (Gray).

Type, T. marmoratus. Pl. X., fig. 2.

Shell turbinated, solid; whirls convex, often grooved or tuberculate aperture large, rounded, slightly produced in front; operculum shelly ar solid, callous outside, and smooth, or variously grooved and mammillate internally horny and pauci-spiral. In *T. sarmaticus* the exterior of the ope culum is botryoidal, like some of the tufaceous deposits of petrifying wells.

Animal with pectinated head-lobes.

Distr., 60 sp. Tropical seas, W. Indies, Medit., Cape, India, China, Australia, New Zealand, Pacific, Peru.

Fossil, 360 sp. (including litorina) L. Silurian—. Universal.

PHASIANELLA, Lam. Pheasant-shell.

Syn., eutropia (Humphr.) Gray. Tricolea, Risso.

Type, P. australis. Pl. X., fig. 3.

Shell elongated, polished, richly coloured; whirls, convex; aperture oval, not pearly; inner lip callous, outer thin; operc. shelly, callous outside, subspiral inside.

Animal with long ciliated tentacles; head-lobes pectinated, wanting in the minute sp.; neck-lobes fringed; sides ornamented with 3 cirri; branchial plume long, partly free; foot rounded in front, pointed behind; its sides moved alternately in walking; lingual teeth even-edged; laterals 5, hooked, denticulated; uncini about 70, gradually diminishing outwards, hooked and denticulated.

Distr., 25 sp. Australia, large sp. India, Philippines; small sp. Medit., Brit., W. Indies, very small sp.

Fossil, 70 sp. Devonian ?—. Europe.

The similarity of the existing Australian fauna, to that of the European oolites, strengthens the probability that some, at least, of these fossil shells are rightly referred to Phasianella.

IMPERATOR, Montf.

Type, I, imperialis, Pl. 10, fig. 4. *Syn.*, calcar.

Shell trochiform, thick, with a flat or concave base; whirls keeled or stellated; aperture angulated outside, brilliantly pearly; operc. shelly.

Distr., 20 sp. ? S. Africa, India, Australia, New Zealand.

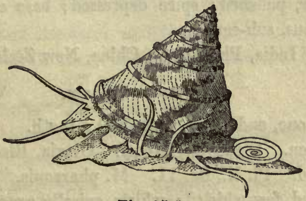

Fig. 87.*

TROCHUS, L.

Etym., *trochus,* a hoop.

Syn., cardinalia, tegula, and livona, Gray. Infundibulum, Montf. Chlorostoma, Sw. Trochiscus, Sby. Monilea, Sw.

Types, T. niloticus. Pl. X., fig. 5. T. zizyphinus. Fig. 87.

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* Fig. 87. *Trochus zizyphinus*, L., Pegwell Bay, Kent.

Shell pyramidal, with nearly a flat base; whirls numerous, flat, variously striated; aperture oblique, rhombic, pearly inside; columella twisted, slightly truncated; outer lip thin; operculum horny, multi-spiral. Fig. 88 (T. pica).

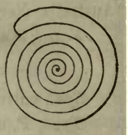

Fig. 88.

Animal with 2 small or obsolete head-lobes between the tentacles; neck lappets large: sides ornamented with lobes, and 3—5 cirri; gill very long, linear; lingual teeth 11, denticulated; uncini—90, diminishing outwards.

Distr., 150 sp. World-wide. Low-water to 15 fathoms; the smaller species range nearly to 100 fathoms.

Fossil, 360 sp. Devonian—. Europe, N. America, Chile.

Sub-genera. Pyramis, Chemn., Tr. obeliscus, Pl. X., fig. 6, columella contorted, forming a slight canal.

Gibbula, Leach. Tr. magus, Brit. Shell depressed, widely umbilicated; whirls tumid. Head-lobes largely developed; lateral cirri 3.

Margarita, Leach. Tr. helicinus. Pl. X., fig. 7. Shell thin; cirri 5 on each side. Distr., 17 sp. Greenland, Brit., Falkland Islands. Near low-water, under stones and sea-weed.

Elenchus, Humph. (= Canthiridus, Montf.) E. iris. Pl. X., fig. 8. Smooth, thin, imperforate, with a prominent base. Australia, N. Zealand. *F. iris* scarcely differs in form from Tr. zizyphinus; *E. badius* is like a pearly phasianella; and *E. varians* (bankivia, Menke) would be called a *chemnitzia,* if fossilized. Pl. X., fig. 9.

ROTELLA, Lamarck.

Etym., diminutive of *rota*, a wheel. (Syn., Helicina, Gray!)

Type, R. vestiaria. Pl. X., fig. 10.

Shell, lenticular, polished; spire depressed; base callous; lingual teeth 13; uncini numerous, sub-equal.

Distr., 10 sp. India, Philippines, China, New Zealand.

MONODONTA, Lam.

Etym., *monos,* one, and *odous,* (odontos) a tooth.

Syn., labio, Oken. Clanculus, Montf. Otavia, Risso.

Types, M. labeo. Pl. X., fig. 11. M. pharaonis. Pl. X., fig. 12.

Shell, turbinated, few-whirled; whirls spirally grooved and granulated; lip thickened internally, and grooved; columella toothed, more or less prominently and irregularly; operc. horny, many-whirled.

Distr., 10 sp? W. Africa, Red Sea, India, Australia.

Fossil, (included with trochus) Devonian—. Eifel.

DELPHINULA (Roissy), Lam.

Etym., diminutive of *delphinus*, a dolphin. (= Cyclostoma, Gray!)

Type, D. laciniata. Pl. X., fig. 13. (= T. delphinus, L.)

Shell orbicular, depressed; whirls few, angulated, rugose, or spiny; aperture round, pearly; peristome continuous; umbilicus open; operculum horny, many-whirled. On reefs, at low-water.

Animal without head-lobes; sides lobed and cirrated.

Distr., 20 sp. Red Sea, India, Philippines, China, Australia.

Fossil, 30 sp.? Trias?—Miocene—. Europe.

Sub-genera. Liotia, Gray. L. gervillii. Pl. X., fig. 14. Aperture pearly, with a regular, expanded border. Operc. multi-spiral, calcarious. *Distr.*, 6 sp. Cape, India, Philippines, Australia. *Fossil*, Eocene—. Brit., France.

Collonia, Gray, 1850. C. marginata. Pl. X., fig. 16. Peristome simple. Operc. calcarious, with a spiral rib on the outer side. *Distr.*, Africa. *Fossil*, Eocene—. Paris.

Cyclostrema, Marryat. C. cancellata, Pl. X., fig. 15. Shell nearly discoidal, cancellated, not pearly; aperture round, simple; umbilicus wide. Operc. spiral, calcarious. *Distr.*, 12 sp. Cape, India, Philippines, Australia, Peru. In 5—17 fathoms. *Serpularia*, Rœmer, has the whirls smooth and dis-united. Eocene, Paris.

ADEORBIS, Searles Wood.

Type, A. sub-carinatus. Pl. X., fig. 17.

Shell minute, not nacreous, depressed, few-whirled, deeply umbilicated; peristome entire, nearly continuous, sinuated in its inner side, and slightly so externally. Operc. shelly, multi-spiral.

Distr., W. Indies—China. Low-water to 60 fathoms.

Fossil, 5 sp. Miocene—. Brit.

EUOMPHALUS, Sowerby.

Etym., *eu*, wide, and *omphalos*, umbilicus.

Syn., schizostoma, Bronn. ~~Maclurea, Leseuer.~~ Ophileta, Vanuxem. Platyschisma, McCoy.

Type, E. pentagonalis. Pl. X., fig. 18.

Shell depressed or discoidal; whirls angular or coronated; aperture polygonal; umbilicus very large. Operc. shelly, round, multi-spiral (Salter).

Fossil, 80 sp., L. sil.—Trias. N. America, Europe, Australia.

Sub-genus. Phanerotinus, J. Sby. 1840, E. cristatus, Phil. Carb. limestone. Brit. Shell discoidal; whirls separate; outer margin sometimes foliaceous.

STOMATELLA, Lam.

Etym., diminutive of *stoma*, the aperture.

Type, S. imbricata. Pl. X., fig. 19.

Shell ear-shaped, regular; spire small; aperture oblong, very large and oblique, nacreous; lip thin, even-edged; operc. circular, horny, multi-spiral. On reefs and under stones at low-water.

Distr., 20 sp. Cape, India, N. Australia, China, Japan, Philippines.

Sub-genus? Gena, Gray. Spire minute, marginal; no operculum. 16 sp. Red Sea, India, Seychelles, Swan River, Philippines (Adams).

BRODERIPIA, Gray.

Etym., named in honour of W. J. Broderip, Esq., the distinguished conchologist.

Type, B. rosea. Pl. X., fig. 20.

Shell minute, limpet-shaped, with a posterior sub-marginal apex; aperture oval, as large as the shell, brilliantly nacreous.

Distr., 3 sp. Philippines; Grimwood's Island, S. Seas (Cuming).

FAMILY X. HALIOTIDÆ.

Shell spiral, ear-shaped or trochiform; aperture large, nacreous; outer lip notched or perforated. No operculum.

Animal with a short muzzle and subulate tentacles; eyes on pedicels at the outer bases of the tentacles; branchial plumes 2; mantle-margin with a posterior (anal) fold or siphon, occupying the slit or perforation in the shell; operc. lobe rudimentary; lingual dentition similar to trochus.

In addition to the true haliotids, we have retained in this group such of the trochi-form shells as have a notched or perforated aperture.

HALIOTIS, L. Ear-shell.

Etym., *halios*, marine, and *ous* (otos) an ear.

Type, H. tuberculata, Pl. X., fig. 21.

Shell ear-shaped, with a small flat spire; aperture very wide, iridescent; exterior striated, dull; outer angle perforated by a series of holes, those of the spire progressively closed. Muscular impresssion horse-shoe shaped, the left branch greatly dilated in front. In *H. tricostalis* (padollus, Montf.) the shell is furrowed parallel with the line of perforations.

Animal with fimbriated head-lobes; side-lobes fimbriated and cirrated; foot very large, rounded. Lingual teeth;—median small; laterals single, beam-like; uncini about 70, with denticulated hooks, the first 4 very large.

The haliotis abounds on the shores of the Channel Islands, where it is called the ormer, and is cooked after being well beaten to make it tender. (Hanley); it is also eaten in Japan. It is said to adhere very firmly to the rocks, with its large foot, like the limpet. The shell is much used for inlaying, and other ornamental purposes.

Distr., 75 sp. Brit., Canaries, Cape, India, China, Australia, New Zealand, Pacific, California.

Fossil, 4 sp. Miocene—. Malta, &c.

Sub-genus? Deridobranchus, Ehrenberg, D. argus, Red Sea. Shell large and thick, like haliotis, but entirely covered by the thick, hard, plaited mantle of the animal.

STOMATIA (Helblin), Lamarck.

Etym., *stoma*, the aperture.

Type, S. phymotis, Pl. X., fig. 22.

Shell like haliotis, but without perforations, their place being occupied by a simple furrow; surface rugose, spirally ridged; spire small, prominent aperture large, oblong, outer margin irregular.

Distr., 12 sp. Java, Philippines, Torres Straits, Pacific. Under stones at low water (Cuming).

Fossil. M. D'Orbigny refers to this genus 18 sp., ranging from the L. Silurian to the chalk, N. America, Europe.

SCISSURELLA, D'Orb.

Etym., diminutive of *scissus*, slit.

Type, S. crispata, Pl. X., fig. 23. *Syn.*, anatomus, Montf.

Shell minute, thin, not pearly; body-whirl large; spire small; surface striated; aperture rounded, with a slit in the margin of the outer lip. Operculate.

Distr., 5 sp. Norway, Brit., Medit. In 7 fathoms water off the Orkneys, and in deep water east of the Zetland Isles.

Fossil, 4 sp. Miocene—. Brit., Sicily.

PLEUROTOMARIA, Defrance.

Etym., *pleura*, side, and *tome*, notch.

Type, P. anglica, Pl. X., fig. 24.

Shell, trochiform, solid, few-whirled, with the surface variously ornamented; aperture sub-quadrate, with a deep slit in its outer margin. The part of the slit which has been progressively filled up, forms a band round the whirls.

Fossil, 400 sp. Lower silurian—chalk. N. America, Europe, Australia. Specimens from clay strata retain their nacreous inner layers, those from the chalk and limestones have lost them, or they are replaced by crystalline spar. Pleurotomariæ with wavy bands of colour have been obtained in the carb. limestone of Lancashire. In this extensive group there are some species which rival the living turbines in magnitude and solidity, whilst others are as frail as ianthina.

Sub-genus. *Scalites*, Conrad (= raphistoma, Hall.) *E.g.*, S. angulatus and stamineus. L. silurian, New York. Shell thin; whirls angular, flat above (tabulated), 8 sp. L. silurian—carb. *Poly-tremaria*, D'Orb., is founded on P. catenata, Koninck, in which the margins of the slit are wavy, converting it into a series of perforations.

MURCHISONIA, D'Archiac.

Etym., named in honour of Sir Roderick I. Murchison.

Type, M. bilineata. Pl. X., fig. 25.

Shell elongated, many-whirled; whirls variously sculptured, and zoned like pleurotomaria; aperture slightly channelled in front; outer lip deeply notched.

The murchisoniæ are characteristic fossils of the palæozoic rocks; they have been compared to elongated pleurotomariæ, or to cerithia with notched apertures; the first suggestion is most probably correct.

Fossil, 50 sp. L. silurian—Permian. N. America, Europe.

Trochotoma, Lycett.

Etym., *trochus,* and *tome,* a notch.

Syn., ditremaria, D'Orb.

Type, T. conuloides. Pl. X., fig. 26.

Shell trochiform, slightly concave beneath; whirls flat, spirally striated, rounded at the outer angles; lip with a single perforation near the margin.

Fossil, 10 sp. Lias—Coral Rag. Brit., France, &c.

? Cirrus, Sowerby.

Etym., *cirrus,* a curl.

Type, C. nodosus, Sby. Min. Con. t. 141 and 219.

Shell sinistral, trochiform, base level; last whirl enlarging rather more rapidly, somewhat irregular.

Fossil, 2 sp. Inf. oolite, Bath oolite. Brit., France.

This genus was founded on a pleurotomaria, a euomphalus, and C. nodosus. (v. Min. Con.) It is still doubtful what species may be referred to it.

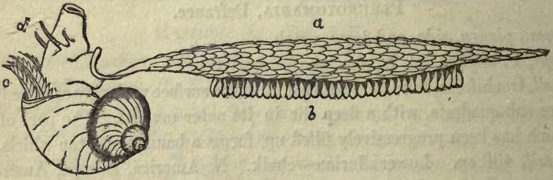

Fig. 89.*

Ianthina, Lam. Violet-snail.

Etym., *ianthina,* violet-coloured.

Type, helix ianthina L. (I. fragilis, Lam.) Pl. X., fig. 27.

Shell thin, translucent, trochiform; nucleus minute, styliform, sinistral; whirls few, rather ventricose; aperture four-sided; columella tortuous; lip thin, notched at the outer angle. Base of the shell deep violet, spire nearly white.

Animal:—head large, muzzle-shaped, with a tentacle and eye-pedicel o each side, but no eyes; foot small, secreting a float composed of numerou cartilaginous air-vesicles, to the under surface of which the ovarian capsule are attached. Lingual ribbon, rachis unarmed; uncini numerous, simpl (like *scalaria*). Branchial plumes 2. Sexes separate.

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* Fig. 89. Ianthina fragilis, Lam. (from Quoy and Gaimard). Atlantic. *a* raft, *b* egg capsules, *c* gills, *d* tentacles and eye-stalks.

Distr., 6 sp. Atlantic, Coral sea.

The ianthinæ, or oceanic-snails, are gregarious in the open sea, whe they are found in myriads, and are said to feed on the small blue acaleph (*velella*). They are frequently drifted to the southern and western Britis shores, especially when the wind continues long from the S.W.; in Swanse bay the animals have been found quite fresh. When handled they exude violet fluid from beneath the margin of the mantle. In rough weather the are driven about and their floats broken, or detached, in which state they a often met with. The capsules beneath the further end of the raft have bee observed to be empty, at a time when those in the middle contained youn with fully formed shells, and those near the animal were filled with egg They have no power of sinking and rising in the water. The raft, which much too large to be withdrawn into the shell, is an extreme modification the operculum.

FAMILY XI. FISSURELLIDÆ.

Shell conical, limpet-shaped; apex recurved; nucleus spiral, often di appearing in the course of growth; anterior margin notched, or apex perf rated; muscular impression horse-shoe shaped, open in front.

Animal with a well-developed head, a short muzzle, subulate tentacle and eyes on rudimentary pedicels at their outer bases; sides ornamented wi short cirri; branchial plumes 2, symmetrical; anal siphon occupying the a terior notch or perforated summit of the shell. Lingual dentition similar trochus.*

FISSURELLA, Lam. Key-hole limpet.

Etym., diminutive of *fissura*, a slit.

Type, F. Listeri. Pl. XI., fig. 1.

Shell oval, conical, depressed with the apex in front of the centre a perforated; surface radiated or cancellated; muscular impression with t points incurved.

In very young shells the apex is entire and sub-spiral; but as the perf ration increases in size it encroaches on the summit and gradually remov it. The key-hole limpets are locomotive; they chiefly inhabit the laminari zone, but range downwards to 50 fms.

Distr., 120 sp. America, Brit., S. Africa, India, China, Australia. California—Cape Horn.

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* Fissurella is the best gasteropod for comparison with the bivalves; its large gill placed one on each side, and its symmetrical shell, pierced with a median orifice f the escape of the out-going branchial current, are unmistakeable indications of hom logies with the lamelli-branchiata. See p. 48.

Fossil, 25 sp. Carb. ? oolites—. Brit., France.

Sub-genera. Pupillia, Gray. F. apertura, Born. (= hiantula, Lam.) Shell smooth, surrounded by a sharp white edge; perforation very large. *Distr.,* S. Africa.

Fissurellidæa, D'Orb. F. hiatula, Lam. (=megatrema, D'Orb.) Shell cancellated; covered by the mantle of the animal. 3 sp. Cape, Tasmania.

(*Macroschisma,* Sw.) F. macroschisma. Pl. XI., fig. 2. Anal aperture close to the *posterior* margin of the shell. The animal is so much larger than its shell, as to be compared to the *testacelle* by Mr. Cuming. Distr., Philippines, Swan river.

Lucapina, Gray. F. elegans, Gray (=aperta, Sby.). Shell white, cancellated, margin crenulated; covered by the reflected mantle. 3 sp. California.

PUNCTURELLA, Lowe.

Syn., cemoria, Leach. Diadora, Gray.

Type, P. noachina. Pl. XI., fig. 3.

Shell conical, elevated, with the apex recurved; perforation in front of the apex, with a raised border internally; surface cancellated.

Distr., 2 sp. Greenland, Boreal America, Norway, N. Brit., Tierra-del-fuego. In 20—100 fathoms water.

Fossil, in the glacial formations of N. Brit.

RIMULA, Defrance.

Etym., diminutive of *rima,* a fissure. (Syn., Rimularia.)

Recent type, R. Blainvillii. Pl. XI., fig. 4.

Shell thin and cancellated, with a perforation near the anterior margin.

Distr., several sp. found on sandy mud at low-water, or dredged in from 10—25 fms. Philippines (Cuming).

Fossil, 3 sp. Bath oolite—coral-rag. Brit., France.

EMARGINULA, Lam.

Etym., dimunitive of *emarginata,* notched.

Type, E. reticulata. Pl. XI., figs. 5, 6.

Shell oval, conical, elevated, with the apex recurved; surface cancellated; anterior margin notched, Muscular impression with recurved points. The *nucleus* (or shell of the fry) is spiral, and resembles *scissurella.* The anterior slit is very variable in extent. The animal of Emarginula (and also of puncturella) has an isolated cirrus on the back of the foot, perhaps representing the operculigerous lobe (Forbes). Lingual dentition; median teeth sub-quadrate; laterals 4, oblong, imbricated; uncini about 60, the first large and thick, with a lobed hook, the rest linear, with serrulated hooks (Lovén).

Distr., 26 sp. W. Indies, Brit., Norway, Philippines, Australia. Range from low-water to 90 fathoms.

Fossil, 40 sp. Trias—. Brit., France.

Sub-genus. Hemitoma, Sw. *Type*, E. octoradiata. (E. rugosa. Pl. XI., figs. 7, 8.) Shell depressed; anterior margin slightly channelled.

PARMÓPHORUS, Blainville. Duck's-bill limpet.

Etym., *parme*, a shield, and *phoreus*, a bearer.

Type, P. australis. Pl. XI., fig. 9. *Syn.*, Scutus, Montf.

Shell lengthened-oblong, depressed; apex posterior; front margin arched Muscular impression horse-shoe shaped, elongated. The shell is smooth an white, and permanently covered by the reflected borders of the mantle. Th animal is black, and very large compared with the shell; its sides are fringe with short cirri, and its eyes sessile on the outer bases of thick tentacles; i is found in shallow-water, and walks freely (Cuming).

Distr., 10 sp. New Zealand, Australia, Philippines, Singapore, Red Sea Cape.

Fossil, 3 sp. Eocene?—. Paris basin.

FAMILY XII. CALYPTRÆIDÆ. Bonnet-limpets.

Shell limpet-like, with the apex more or less spiral; interior simple, o divided by a shelly-process, variously shaped, to which the adductor muscle are attached.

Animal with a distinct head; muzzle lengthened; eyes on the externa bases of the tentacles; branchial plume single. Lingual teeth single, uncini 3

The bonnet-limpets are found adhering to stones and shells; most of the appear never to quit the spot on which they first settle, as the margins their shells become adapted to the surface beneath, whilst some wear awa the space beneath their foot, and others secrete a shelly base. Both thei form and colour depend on the situation in which they grow; those found i the cavities of dead shells are nearly flat, or even concave above, and colourless. They are presumed to feed on the sea-weed growing round them, or o animacules; a *calyptræa*, which Professor Forbes kept in a glass, ate a sma sea slug (*goniodoris*) which was confined with it. Both *calyptræa* and *pileopsis* sometimes cover and hatch their spawn in front of their foot (Alder an Clarke).

Mr. Gray arranges the bonnet-limpets next after the vermetidæ; thei lingual dentition is like *velutina*.

CALYPTRÆA, Lam. Cup-and-saucer limpet.

Etym., *calyptra*, a (lady's) cap.

Syn., lithedaphus, Owen.

Types, C. equestris. Pl. XI., fig. 10. C. Dillwynnii, fig. 11.

Shell conical; limpet-shaped; apex posterior, with a minute, spira nucleus; margin irregular; interior with a half-cup shaped process on th posterior side, attached to the apex, and open in front. Surface rugose o cancellated.

Animal with a broad muzzle; tentacles rather short; lanceolate; eyes on bulgings at the outer bases of the tentacles; mantle-margin simple, sides plain. Found under stones, between tide-marks, and in shallow water (Cuming).

Distr., 50 sp. W. Indies, Honduras, Brit., Medit., Africa, India, Philippines, China, Japan, New Zealand, Gallapagos, Chili.

Fossil, 30 sp. Carb? chalk—. Brit., France, &c.

Sub-genera. Crucibulum, Schum. (Dispotæa, Say., Calypeopsis, Less.) Ex. C. rudis, Pl. XI., fig. 12. Shell spinulose; internal cup entire; attached by one of its sides. Distr., W. America, Japan, W. Indies. Found on shells, with its base worn, or smoothed by a shelly deposit (Gray). Between this section and the next there are several intermediate forms.

Trochita, Schum. (Infundibulum, J. Sby., Galerus, Humph. Trochatella and Siphopatella, Lesson.) T. radians, Pl. XI., figs. 13, 14. (=Patella trochoides, Dillw.) T. sinensis, Pl. XI., fig. 15. Shell circular, more or less distinctly spiral; apex central; interior with a more or less complete subspiral partition. Distr., chiefly tropical, but ranges from Britain to New Zealand. *T. prisca* (McCoy) is found in the carb. limestone in Ireland; and several large species occur in the London clay and Paris basin. The recent C. sinensis — the "China-man's hat" of collectors—is found on the southern shores of England, and in the Mediterranean, in 5—10 fms. water (Forbes). Its lingual dentition is given by Lovén;— median teeth broad, hooked, denticulated; uncini 3, the first hooked and serrated, 2, 3 claw-shaped, simple.

CREPIDULA, Lam.

Etym., *crepidula,* a small sandal.

Type, C. fornicata, Pl. XI., fig. 16. *Syn.*, crypta, Humph.

Shell oval, limpet-like; with a posterior, oblique marginal apex; interior polished, with a shelly partition covering its posterior half.

The crepidulæ resemble the fresh-water navicellæ in form; but the internal ledge which mimics the columella of the nerite, is here the basis of the adductor muscles.

They are sedentary on stones and shells, in shallow water, and are sometimes found adhering to one another in groups of many successive generations. The specimens or species which live inside empty spiral shells are very thin, nearly flat, and colourless.

Distr., 40 sp. W. Indies, Honduras, Medit., W. Africa, Cape, India, Australia, W. America.

Fossil, 14 sp. Eocene—. France, N. America, Patagonia.

PILEOPSIS, Lam. Bonnet-limpet.

Etym., *pileos,* a cap, and *opsis,* like.

Syn., capulus, Montf. Brocchia, Bronn.

Type, P. hungaricus, Pl. XI., fig. 17. P. militaris, Pl. XI., fig. 18.

Shell conical; apex posterior, spirally recurved; aperture rounded; muscular impression horse-shoe shaped.

Animal with a fringed mantle-margin; lingual teeth like *calyptræa.*

P. hungaricus (the Hungarian-bonnet) is found on oysters, in 5 to 15 fms. water; more rarely as deep as 80 fms., and then very small. P. militaris is extremely like a *velutina.*

Distr., 7 sp. W. Indies, Norway, Brit., Medit., India, Australia, California.

Fossil, 20 sp. Lias—. Europe.

Sub-genus. Amathina, Gray. A. tricarinata, Pl. XI., fig. 19. Shell depressed, oblong; apex posterior, not spiral, with three strong ribs diverging from it to the anterior margin.

Platyceras, Conrad (acroculia, Phil.). P. vetustus. Carb., limestone. Brit.

Fossil, 20 sp. Devonian—Trias. America, Europe.

HIPPONYX, Defrance.

Etym., *hippos*, a horse, and *onyx*, a hoof.

Type, H. cornucopia, Pl. XI., figs. 20, 21.

Shell thick, obliquely conical, apex posterior; base shelly, with a horse-shoe-shaped impression, corresponding to that of the adductor muscle.

Distr., 10 sp. W. Indies. Persian Gulf, Philippines, Australia, Pacific, W. America.

Fossil, 10 sp. U. chalk—. Brit., France, N. America.

Sub-genus. Amalthea, Schum. A. conica. Like hipponyx, but forming no shelly base; surface of attachment worn and marked with a crescent-shaped impression. Often occurs on living shells, such as the large turbines, and turbinellæ of the Eastern seas.

FAMILY XIII. PATELLIDÆ. Limpets.

Shell conical, with the apex turned forwards; muscular impression horse-shoe-shaped, open in front.

Animal with a distinct head, furnished with tentacles, bearing eyes at their outer bases; foot as large as the margin of the shell; mantle plain or fringed. Respiratory organ in the form of one or two branchial plumes, lodged in a cervical cavity; or of a series of lamellæ surrounding the animal, between its foot and mantle. Mouth armed with horny jaws, and a long ribbon-like tongue, furnished with numerous teeth, each consisting of a pellucid base and an opaque hooked apex.

The order *cyclo-branchiata* of Cuvier included the chitons and the limpets, and was characterised by the circular arrangement of the branchiæ. At a comparatively recent period it was ascertained that some of the patellæ (*acmæa*) had a free, cervical gill; whilst the chitons exhibited too many peculiaritics to admit of being associated so closely with them. Professor

Forbes has very happily suggested that the cyclo-branchiate gill of patella is, in reality, a single, long branchial plume, originating on the left side of the neck, coiled backwards round the foot, and attached throughout its length. This view is confirmed by the circumstance that the gill of the sea-weed limpets (*nacellæ*) does not form a complete circle, but ends without passing in front of the animal's head.

PATELLA, L. Rock limpet.

Etym., *patella*, a dish. *Syn.*, helcion, Montf.

Ex., P. longicostata, Pl. XI., fig. 22.

Shell oval, with a sub-central apex; surface smooth, or ornamented with radiating striæ or ribs; margin even or spiny; interior smooth.

Animal with a continuous series of branchial lamellæ; mantle-margin fringed; eyes sessile, externally, on the swollen bases of the tentacles; mouth notched below. Lingual teeth 6, of which 4 are central, and 2 lateral; uncini 3.

The tongue of the common British limpet (P. vulgata) is rather longer than its shell; it has 160 rows of teeth, with 12 teeth in each row, or 1,920 in all (Forbes.) The limpets live on rocky coasts, between tide-marks, and are consequently left dry twice every day; they adhere very firmly, by atmospheric pressure (15lbs per square inch), and the difficulty of detaching them is increased by the form of the shell. On soft calcarious rocks, like the chalk of the coast of Thanet, they live in pits half an inch deep, probably formed by the carbonic acid disengaged in respiration; on hard limestones only the aged specimens are found to have worn the rock beneath, and the margin of their shell is often accommodated to the inequalities of the surrounding surface. These circumstances would seem to imply that the limpets are sedentary, and live on the sea-weed within reach of their tongues, or else that they return to the same spot to roost. On the coast of Northumberland we have seen them sheltering themselves in the crevices of rocks, whose broad surfaces, overgrown with nullipores, were covered with irregular tracks, apparently rasped by the limpets in their nocturnal excursions.*

The limpet is much used by fishermen for bait; on the coast of Berwickshire nearly 12,000,000 have been collected yearly, until their numbers are so decreased that collecting them has become tedious (Dr. Johnston). In the north of Ireland they are used for human food, especially in seasons of scarcity; many tons weight are collected annually near the town of Larne alone (Pattison).

On the western coast of S. America there is a limpet which attains the diameter of a foot, and is used by the natives as a basin (Cuming).

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* If limpets are placed in stale water, or little pools exposed to the hot sun, they creep out more quickly than one would expect; the tracks they leave are very peculiar and not likely to be mistaken when once seen.

Distr., 100 sp. Brit., Norway, &c. World-wide.

Fossil, above 100 sp. of patellidæ, including *acmæa*, L. silurian—. N. America, Europe.

Sub-genera. Nacella, Schum. (=patina, Leach.) Example, P. pellucida. Pl. XI., fig. 23. Shell thin; apex nearly marginal. Animal with the mouth entire below. Branchiæ not continued in front of the head. Found on the fronds and stalks of sea-weeds. Brit., Cape, Cape Horn.

Scutellina, Gray. S. crenulata. Shell with a broad margin, internally. 7 sp. Red Sea—Philippines—Pacific—Panama (Cuming).

Metoptoma, Phillips. M. pileus Ph. Shell limpet-like, side beneath the apex truncated. Resembling the posterior valve of a chiton. 7 sp. Carb. limestone. Brit.

ACMÆA, Eschscholtz.

Etym., *acme*, a point.

Syn., tectura, M. Edw. Lottia and scurria, Gray. Patelloida, Quoy.

Type, A. testudinalis. Pl. XI., fig. 24.

Shell like patella. *Animal* with a single pectinated gill; lodged in a cervical cavity, and exserted from the right side of the neck when the creature walks. Lingual teeth 3 on each side of the median line. Low-water to 30 fms. (Forbes.)

Distr., 20 sp. Norway, Brit., Australia, Pacific, W. America.

Sub-genera. Lepeta, Gray (= pro-pilidium, Forbes). Patella cæca, Müll. Shell minute, apex *posterior*. Animal blind. Brit. 30—90 fms.

Pilidium, Forbes. P. fulva, Müll. Brit. 20—80 fathoms water. Shell small, apex anterior. Animal blind; gills 2, not projecting; mantle even-edged. Both lepeta and pilidium have large single median teeth, with trilobed hooks; and 2 hooked uncini on each side.

GADINIA (Adanson), Gray.

Type, G. peruviana. Plate XI., fig. 26. *Syn.*, mouretia, Sby.

Shell conical; muscular impression horse-shoe shaped, the right side shortest, terminating at the siphonal groove.

Animal with a single cervical gill; tentacles expanded, funnel-shaped.

Distr., 8 sp. Medit., Red Sea, Africa, Peru.

Fossil, 1 sp. Sicily.

? SIPHONARIA, Blainville.

Type, S. sipho. Pl. XI., fig. 25.

Shell like patella; apex sub-central, posterior; muscular impression horse-shoe shaped, divided on the right side by a deep siphonal groove, which produces a slight projection on the margin.

Animal with a broad head, destitute of tentacles; eyes sessile on prominent rounded lobes; gill ? single. The siphonariæ are found between tide-marks, like limpets; Mr. Gray places them with the pulmonifera, between auriculidæ and cyclostomidæ.

Distr., 30 sp. Cape, India, Philippines, Australia, New Zealand, Pacific, Gallapagos, Peru, Cape Horn (Cuming).

Fossil, 3 sp. Miocene —.

FAMILY XIV., DENTALIADÆ. Tooth-shells.

DENTALIUM, L.

Type, D. elephantinum. Pl. XI., fig. 27.

Shell tubular, symmetrical, curved, open at each end, attenuated posteriorly; surface smooth or longitudinally striated; aperture circular, not constricted.*

Animal attached to its shell near the posterior, anal orifice; head rudimentary, eyes 0, tentacles 0; oral orifice fringed; foot pointed, conical, with symmetrical side-lobes, and an attenuated base, in which is a hollow communicating with the stomach. Branchiæ 2, symmetrical, posterior to the heart; blood red (Clarke); sexes united? Lingual ribbon wide, ovate; rachis 1-toothed; uncini single, flanked by single unarmed plates.

The tooth-shells are animal-feeders, devouring foraminifera and minute bivalves; they are found on sand, or mud, in which they often bury themselves. The British sp. range from 10—100 fms. (Forbes.)

Distr., 30 sp. W. Indies, Norway, Brit., Medit., India.

Fossil, 70 sp. Devonian—. Europe, Chile.

FAMILY XV., CHITONIDÆ.

CHITON, L.

Etym., *chiton*, a coat of mail.

Ex., C. squamosus, spinosus, fascicularis, fasciatus. Pl. XI., figs. 28—31.

Shell composed of 8 transverse imbricating plates, lodged in a coriaceous mantle, which forms an expanded margin round the body. The first seven plates have posterior apices; the eighth has its apex nearly in front. The six middle plates are each divided by lines of sculpturing into a dorsal and two lateral areas. All are inserted into the mantle of the animal by processes (apophyses) from their front margins. The posterior plate is considered homologous with the limpet-shell, by Mr. Gray; the other plates appear like portions of its anterior slope, successively detached. The border of the mantle is either bare, or covered with minute plates, hairs, or spines.

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* D. gadus of Montagu is an annelide, belonging to the genus *ditrupa*.

Animal with a broad creeping disk like the limpet; proboscis armed with cartilaginous jaws, and a long linear tongue; lingual teeth 3; median small, laterals large, with dentated hooks; uncini 5, trapezoidal, one of them erect and hooked. No eyes, or tentacles. Branchiæ forming a series of lamellæ between the foot and the mantle, round the posterior part of the body. The heart is central, and elongated like the dorsal vessel of the annelides; the sexes are united; the re-productive organs are symmetrically repeated on each side, and have two orifices; the intestine is straight, and the anal orifice posterior and median.

Distr. More than 200 species are known; they occur in all climates throughout the world; most abundant on rocks at low-water, but frequently obtained by dredging in 10—25 fathoms water. Some of the small British species range as deep as 100 fms. (Forbes.) W. Indies, Europe, S. Africa, Australia, and New Zealand, California to Chiloë.

Fossil, 24 sp. Silurian—. Brit., Belgium, &c.

*Sub-genera.** *Chiton,* (Syn., lophurus, Poli. Radsia, callo-chiton, ischno-chiton, and lepto-chiton, Gray).

Ex., C. squamosus. Pl. XI., fig. 28. Border tessellated.

Distr. Brazil, W. Indies, Newfoundland, Greenland, Brit., Medit., Cape, Philippines, Australia, New Zealand, W. America.

Tonicia, Gray. C. elegans. Margin bare. *Distr.* Greenland, C. Horn, New Zealand, Valparaiso.

Acanthopleura, Guilding. C. spinosus. Pl. XI., fig. 29. Margin covered with spines, or elongated scales. *Syn.* Schizo-chiton, corephium, plaxiphora, onycho-chiton, enoplo-chiton, Gray. *Distr.* W. Indies, C. Horn, Falklands, Africa, Philippines, Australia, New Zealand, Valparaiso.

Mopalia, Gray. C. Hindsii. Border hairy. *Distr.,* W. America, Falkland Islands.

Katharina, Gray, C. tunicatus. Mantle covering all but the centre of the plates. *Distr.* New Zealand, W. America.

Cryptochiton, Gray, "Saw-dust chiton." C. amiculatus. Valves covered with scaly epidermis. *Syn.,* cryptoconchus, Sw. Amicula, Gray. *Distr.,* California, New Zealand.

Acanthochites, Leach. C. fascicularis. Pl. XI., fig. 30. Border ornamented with tufts of slender spines, opposite the plates. *Distr.,* Brit., Medit. New Zealand.

Chitonellus, Lam. C. fasciatus, Quoy. Pl. XI., fig. 31. Border velvety; exposed portion of the plates small, distant; apophyses close together. *Distr.*, 10 sp. W. Indies, W. Africa, Philippines, Australia, Pa Panama. The chitonellæ are found in fissures of coral rock (Cuming).

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* The sub-genera of Mr. Gray are founded on the form of the *plates of insertion*; they are described in detail in the proceedings of the Zoological Society. Dr. Middendorf employs the number of the *branchial laminæ* for distinguishing the sections.

Grypho-chiton, Gray. C. nervicanus.

Helminthochiton, Salter, 1847. H. Griffithii, Salter Geol. Journ. Plate sub-quadrate, not covered by the mantle; apophyses widely separated. *Fossil.* Silurian. Ireland.

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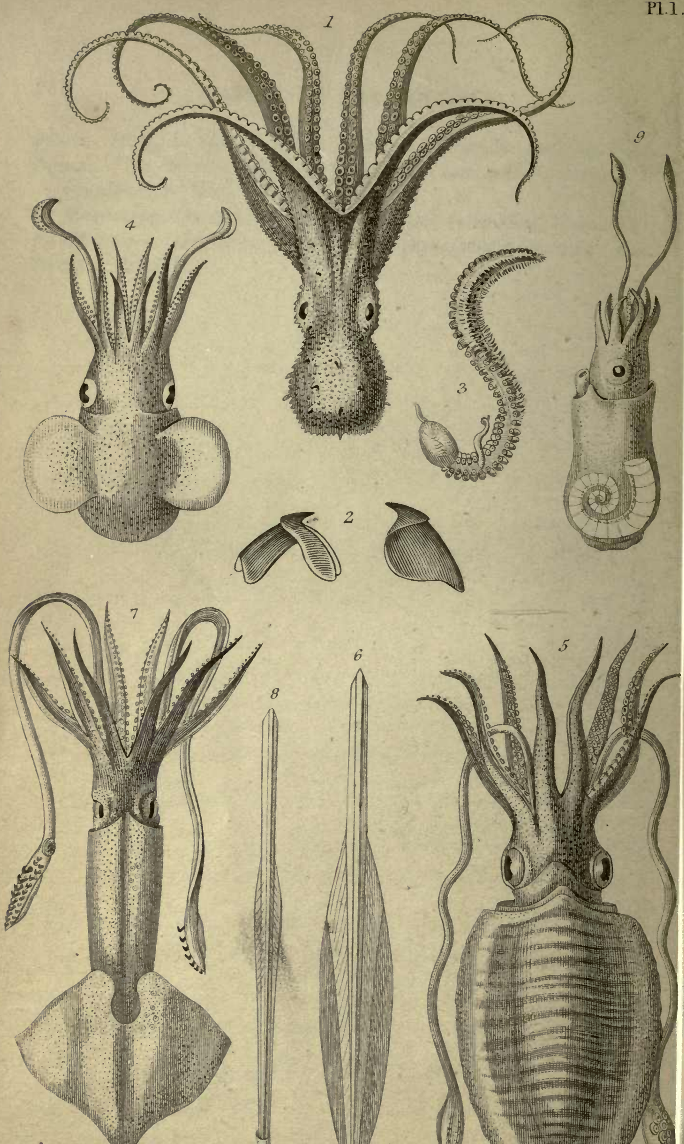
Pl. 1.



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EXPLANATION OF THE PLATES.

The principal specimens figured were kindly communicated by Mrs. J. E. Gray, Mr. Hugh Cuming, Major W. E. Baker, Mr. Laidlay of Calcutta, Mr. Pickering, Sir Chas. Lyell, Mr. Sylvanus Hanley, Mr. James Tennant, and Mr. Lovell Reeve.

The fractions shew the number of times (or diameters) the figures are reduced, or magnified.

PLATE I.

Octopodidæ.

	PAGE
1. Octopus tuberculatus, Bl. ⅕. Mediterranean	67
2. ——— (*mandibles*)	62
3. Tremoctopus violaceus, ♂. Chiaje. Messina	65, 68

Teuthidæ.

4. Sepiola oceanica, Orb. Atlantic	71
6. Loligo vulgaris, Lam. (*gladius*). ¼. Britain	69
7. Onychoteuthis Bartlingii, Le Sueur. ¼. Indian Ocean	72
8. ——— (*gladius*). ⅛.	72

Sepiadæ.

5. Sepia officinalis, L. ⅙. Britain	76

Spirulidæ.

9. Spirula lævis, Gray. ½. New Zealand	77

PLATE II.

Argonautidæ.

		PAGE
1.	Argonauta hians, Solander, $\frac{1}{2}$. China	66

Teuthidæ.

8.	Beloteuthis subcostata, Münst. $\frac{1}{4}$. U. Lias, Wurtemberg	70

Belemnitidæ.

	Belemnites Puzosianus, Orb. $\frac{1}{5}$. Oxford Clay, Chippenham	73
6.	Belemnitella mucronata, Sby. $\frac{1}{4}$. U. Chalk, Norwich	74
9.	Conoteuthis Dupiniana, Orb. Neocomian, France	76

Sepiadæ.

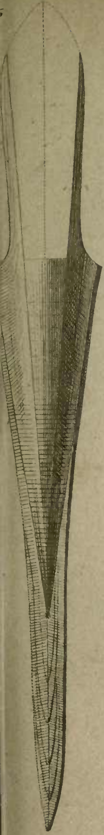
2.	Sepia Orbigniana, Fér. $\frac{1}{2}$. Mediterranean	76
3.	—— (*Belosepia*) sepioïdes, Bl. $\frac{1}{2}$. Eocene, Sussex	76
4.	Spirulirostra Bellardii, Orb. $\frac{4}{3}$. Miocene, Turin	76
7.	Beloptera belemnitoïdes, Bl. $\frac{2}{3}$. Eocene, Sussex	76

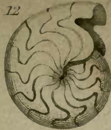
Nautilidæ.

10.	Nautilus radiatus, Sby. $\frac{1}{4}$. Neocomian, Kent	83
11.	——— bidorsatus, Schl. (*upper mandible* = Rhyncholites hirundo, F. Biguet.) $\frac{2}{3}$. Muschelkalk, Bavaria	81
12.	——— (*Aturia*) zic-zac, Sby. Eocene, Highgate	86
16.	Clymenia striata, Münst. Devonian, S. Petherwin	87

Orthoceratidæ.

14.	Orthoceras gigantum, Sby. (*section.*) $\frac{1}{24}$. Carb. limestone, Britain	88
15.	Phragmoceras ventricosum, Stein. $\frac{1}{5}$. L. Ludlow-rock, Salop	90
13.	Gyroceras eifeliense, Arch. (*section.*) $\frac{1}{2}$. Devonian, Eifel	91





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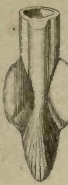

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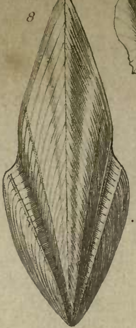

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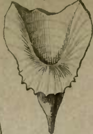

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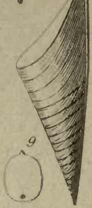

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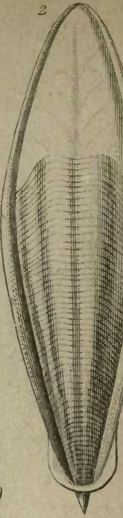

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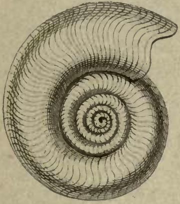

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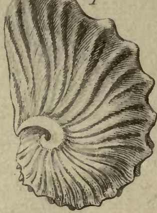

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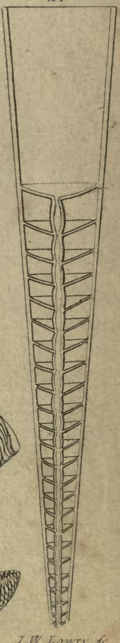

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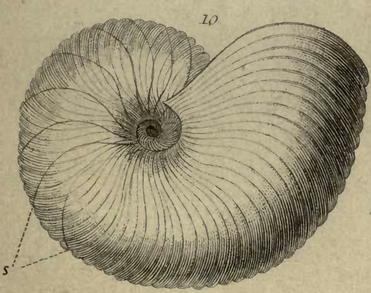

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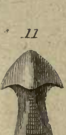

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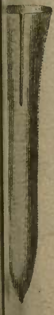

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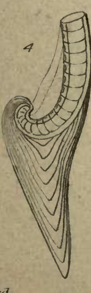

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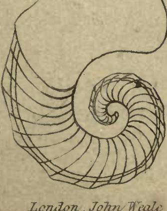

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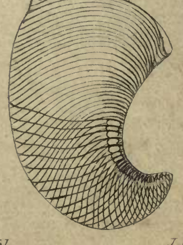

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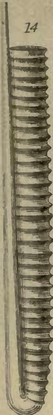

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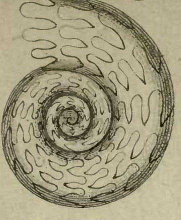

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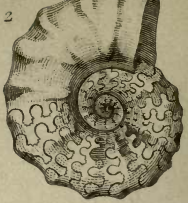

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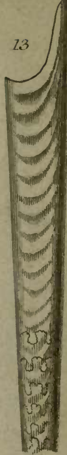

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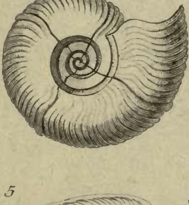

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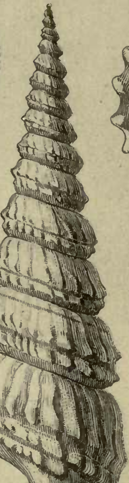

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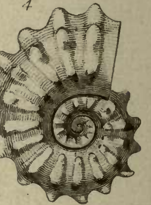

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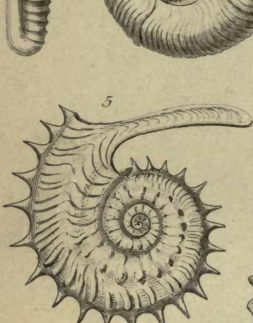

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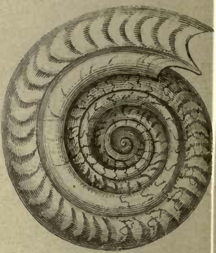

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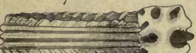

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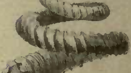

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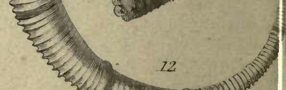

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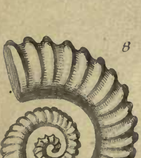

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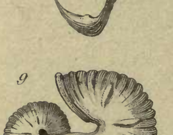

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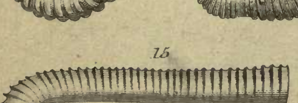

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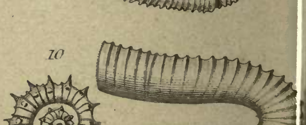

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PLATE III.

Ammonitidæ.

PAGE
1. Goniatites Henslowi, Sby. ⅓. Carb. limestone, Isle of Man 93
2. Ceratites nodosus, Brug. ⅓. Muschel-kalk, Wurtemburg 93
3. Ammonites planulatus, Sby. ½. Chalk-marl, Sussex 94
4. ——— rhotomagensis, Brongn. ½. Chalk-marl, Sussex 94
5. ——— Jason, Reinecke. ½. Oxford clay, Chippenham......... 94
6. ——— bifrons, Brug. ¼. Lias, Whitby 94
7. ——— bisulcatus, Brug. ¼. Lias, Lyme Regis................. 94
8. Crioceras cristatum, Orb. ⅔. Gault, S. France 95
9. Scaphites æqualis, Sby. ⅔. Chalk-marl, Sussex 95
10. Ancyloceras spinigerum, Sby. ⅔. Gault, Folkstone 95
11. Helicoceras rotundum, Sby. Gault, Folkestone 95
12. Toxoceras annulare, Orb. ¼. Neocomian, S. France 95
13. Baculites anceps, Lam. ½. Chalk, France 97
14. Ptychoceras Emericianum, Orb. ⅔. Neocomian, S. France 96
15. Hamites attenuatus, Sby. ⅓. Gault, Folkstone 96
16. Turrilites costatus, Lam. ⅓. Chalk-marl, Sussex 96

PLATE IV.

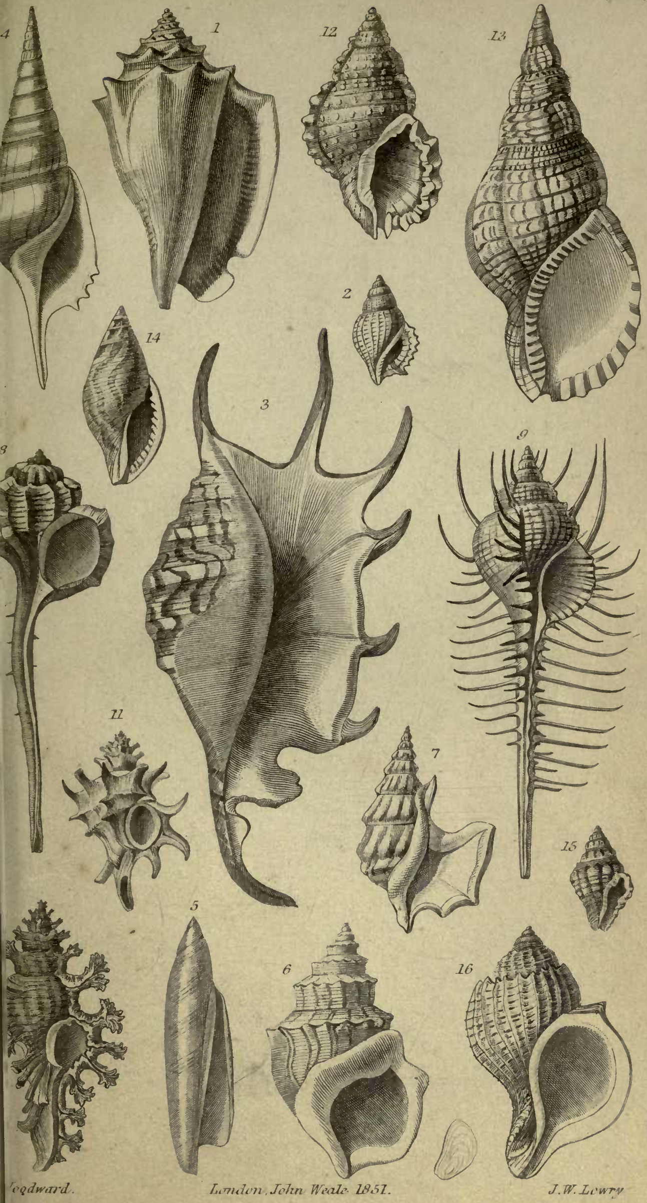
Strombidæ.

		PAGE
1.	Strombus pugilis, L. ½. W. Indies	104
2.	—— Bartonensis, Sby. Eocene, Hants	105
3.	Pteroceras lambis, L. ½. China	105
4.	Rostellaria curta, Sby. ⅓. Kurachee	105
5.	Seraphs terebellum, L. ⅔. China	106
6.	Struthiolaria straminea, Gm. ½. New Zealand	130
7.	Aporrhais pes-pelecani. L. ⅔. Britain	129

Muricidæ.

8.	Murex haustellum, L. ½. China	106
9.	—— tenuispina, Lam. ½. Moluccas	106
10.	—— palma-rosæ, Lam. ⅓. Ceylon	106
10.*	—— erinaceus, L. (*operculum*). Britain	106
11.	Typhis pungens, Soland. Eocene, Barton	106
12.	Ranella granifera, Lam. ⅔. N. Australia	107
13.	Triton tritonis, L. ⅙. New Guinea—Pacific	107
14.	Pisania striata, Gm. sp. Mediterranean	107
15.	—— (*Enzina*) turbinella, Kiener. W. Indies	107
16.	Trophon Magellanicus, Gm. ½. Tierra-del-fuego	109

Pl. 4.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Pl. 5

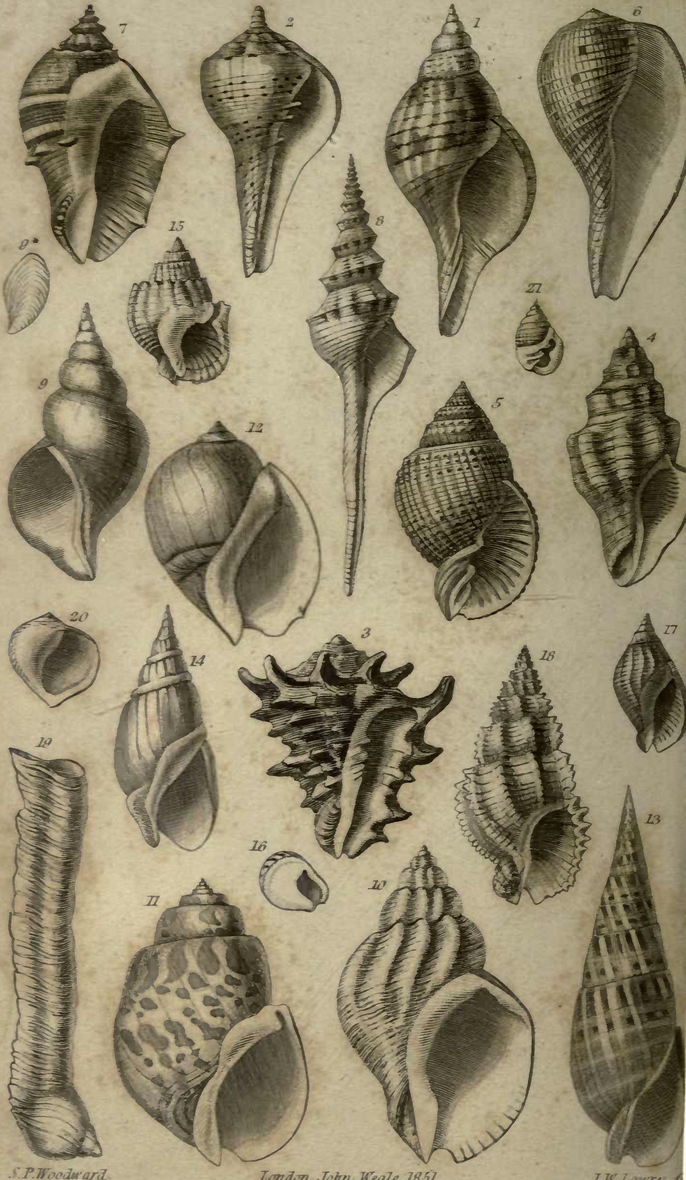
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PLATE V.

Muricidæ.

		PAGE
1.	Fasciolaria tulipa, L. $\frac{1}{2}$. W. Indies	107
2.	Turbinella pyrum, L. $\frac{1}{3}$. Ceylon	108
3.	——— (*Cynodonta*) cornigera, Lam. $\frac{1}{2}$. Moluccas	108
4.	——— (*Latirus*) gilbula, Gm. sp. $\frac{1}{2}$. Australia	108
5.	Cancellaria reticulata, Dillw. sp. ~~California~~ W. Indies	108
6.	Pyrula reticulata, Lam. $\frac{1}{2}$. China	109
7.	——— (*Myristica*) melongena, L. $\frac{1}{2}$. ~~China~~ W. Indies	109
8.	Fusus colus, L. $\frac{1}{2}$. Ceylon	109
9.	—— (*Chrysodomus*) antiquus, Müll. (var. contrarius, Sby.) Red	
9*.	—— (*operculum*). [Crag, Walton, Essex	109

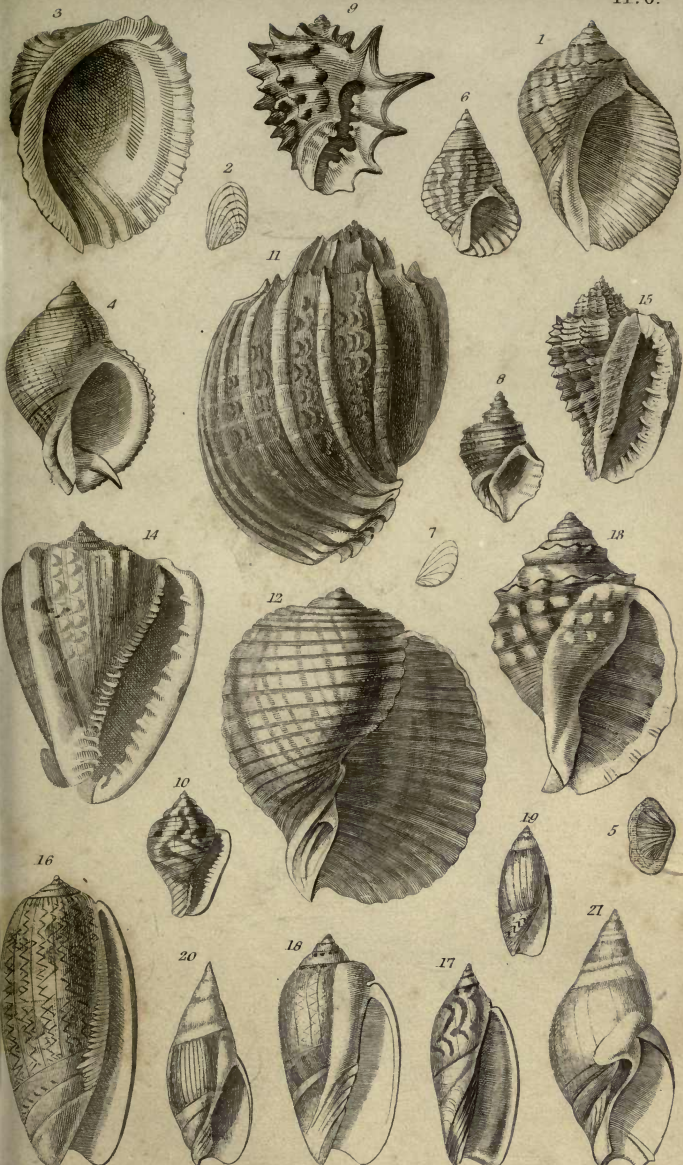
Buccinidæ.

10.	Buccinum undatum, L. $\frac{1}{2}$. Britain	110
11.	Eburna spirata, L. sp. $\frac{2}{3}$. Ceylon	111
12.	Pseudoliva plumbea, Chemn. sp. $\frac{2}{3}$. W. America	111
13.	Terebra maculata, L. sp. $\frac{1}{2}$. Moluccas	111
14.	——— (*Bullia*) semiplicata, Gray. S. Africa	111
15.	Nassa arcularia, L. sp. $\frac{2}{3}$. Moluccas	112
16.	—— (*Cyclonassa*) neritea, L. sp. Mediterranean	112
17.	—— (*Cyllene*) Oweni, Gray. E. Africa	112
18.	Phos senticosus, L. sp. $\frac{2}{3}$. N. Australia	112
19.	Magilus antiquus, Montf. $\frac{1}{2}$. Red Sea	114
20.	——— *do. young*. (*Leptoconchus*)	114
21.	? Ringicula ringens, Lam. $\frac{2}{1}$. Eocene, Paris	112

PLATE VI.

Buccinidæ.

		PAGE
1.	Purpura persica, L. sp. $\frac{1}{3}$. India	113
2.	——— lapillus, L. sp. (operculum.) Britain	113
3.	——— (*Concholepas*) peruviana, Lam. $\frac{1}{2}$. Peru	113
4.	Monoceros imbricatum, Lam. $\frac{2}{3}$. Cape Horn	113
5.	Pedicularia sicula, Sw. Sicily	113
6.	Planaxis sulcata, Brug. sp. India	114
7.	—————, (operculum).	114
8.	Trichotropis borealis, Brod. N. Britain	108
9.	Ricinula arachnoïdes, Lam. China	114
10.	Columbella mercatoria, Gmel. sp. W. Indies	116
11.	Harpa ventricosa, Lam. $\frac{1}{2}$. Mauritius	116
12.	Dolium galea, L. sp. $\frac{1}{3}$. Mediterranean	115
13.	Cassidaria echinophora, L. $\frac{1}{2}$. Medit.	115
14.	Cassis flammea, L. China	114
15.	Oniscia cancellata, Sby. China	114
16.	Oliva porphyria, L. $\frac{1}{2}$. Panama	116
17.	—— (*Agaronia*) hiatula, Gm. sp. $\frac{2}{3}$. W. Africa	117
18.	—— (*Scaphula*) utriculus, Gm. sp. $\frac{2}{3}$. Africa	117
19.	—— (*Olivella*) jaspidea, Gm. sp. W. Indies	117
20.	Ancillaria buccinoïdes, Lam. $\frac{2}{3}$. Eocene, Isle of Wight	117
21.	——— glabrata, L. sp. $\frac{1}{2}$. W. Indies	117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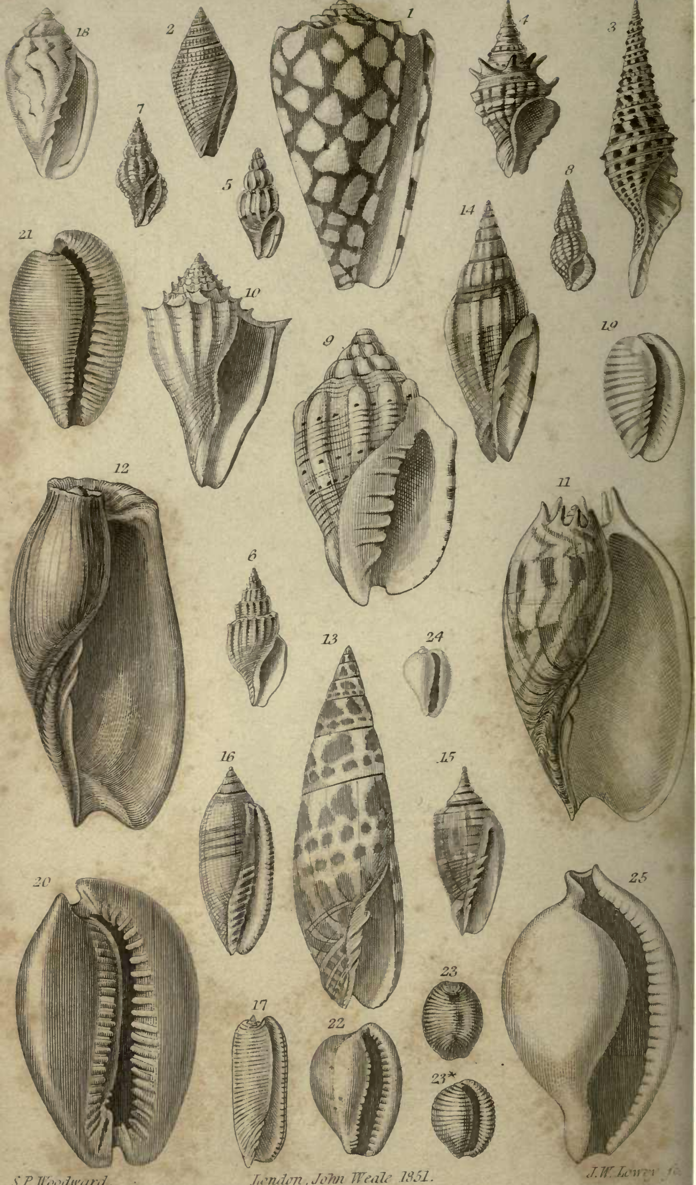
Pl. 7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23*

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PLATE VII.

Conidæ.

PAGE
1. Conus marmoreus Gm. $\frac{2}{3}$. China 117
2. —— (*Conorbis*) dormitor, Solander. Eocene, Barton 117
3. Pleurotoma Babylonica, L. sp. $\frac{2}{3}$. China 118
4. Clavatula mitra, Gray. W. Africa 118
5. Mangelia taenïata, Desh. $\frac{2}{1}$. Mediterranean 118
6. Bela turricula, Mont. sp. Britain 118
7. Defrancia linearis, Bl. sp. $\frac{2}{1}$. Medit. 118
8. Lachesis minima, Mont. sp. $\frac{2}{1}$. Britain 118

Volutidæ.

9. Voluta musica, L. $\frac{1}{2}$. W. Indies 119
10. Volutilithes spinosus, L. sp. $\frac{2}{3}$. Eocene, Barton 119
11. Melo diadema, Lam. sp. $\frac{1}{3}$. New Guinea 119
12. Cymba proboscidalis, Lam. sp. $\frac{1}{4}$. W. Africa 119
13. Mitra episcopalis, D'Arg. $\frac{1}{2}$. Ceylon 119
14. —— vulpecula, L. $\frac{2}{3}$. Singapore 120
15. —— (*Imbricaria*) conica, Schum. ~~Philippines~~ Tahiti 120
16. —— (*Cylindra*) crenulata, Chemn. China 120
17. Volvaria bulloïdes, Lam. Eocene, Grignon 120
18. Marginella nubeculata, Lam. $\frac{2}{3}$. W. Africa 120
19. ———— (*Persicula*) lineata, Lam. W. Africa 120

Cypræidæ.

20. Cypræa Mauritiana, L. $\frac{1}{2}$. India—Pacific 121
21. ——— (*Cyprovula*) capensis. Gray. $\frac{2}{3}$. S. Africa 121
22. ——— (*Luponia*) algoënsis, Gray. S, Africa 121
23, 23* ——— (*Trivia*) europæa, Mont. Britain 122
24. Erato lævis, Donovan. Britain 122
25. Ovulum ovum, L. sp. $\frac{1}{2}$. New Guinea 122

PLATE VIII.

Naticidæ.

		PAGE
1.	Natica canrena, L. sp. $\frac{2}{3}$. China	123
2.	—— (*Globulus*) sigaretina, Lam. $\frac{2}{3}$. Eocene, Paris	123
3.	—— (*Cernina*) fluctuata. Sby. $\frac{1}{2}$. Philippines	123
4.	Sigaretus haliotoides, L. sp. $\frac{2}{3}$. W. Indies	124
5.	——— (*Naticina*) papilla, Chemn. sp. Africa	124
6.	Lamellaria perspicua, Mont. Mediterranean	124
7.	Velutina lævigata, L. sp. Britain	124
8.	Narica cancellata, Chemn. sp. Pacific	124
9.	Neritopsis radula, L. sp. Sandwich Islands	141

Pyramidellidæ.

10.	Pyramidella auris-cati, Chemn. sp. Mauritius	125
11.	———— (*Obeliscus*) dolabrata, Gmel. sp. W. Indies	125
12.	Odostomia plicata, Mont. sp. $\frac{2}{1}$. Britain	125
13.	Chemnitzia elegantissima, Mont. sp. $\frac{2}{1}$. Weymouth	126
14.	Eulima polita, L. Britain	126
15.	Stylifer astericola, Brod. Philippines	126

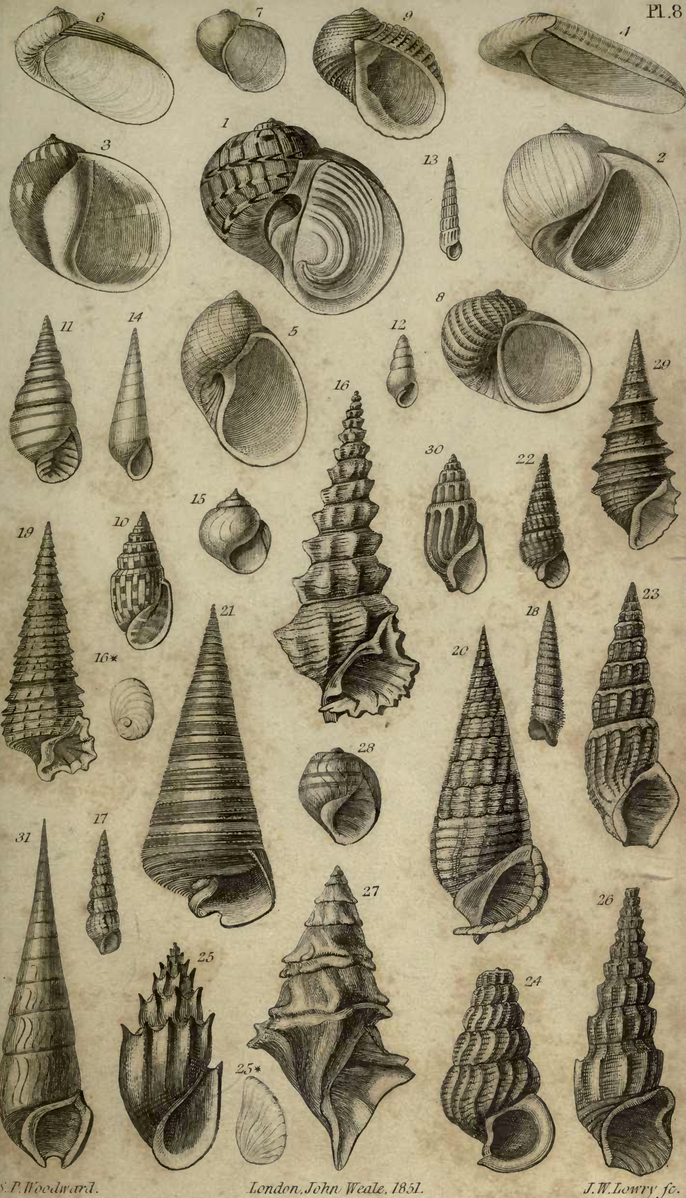
Cerithidæ.

16, 16*.	Cerithium nodulosum, Brug. $\frac{1}{2}$. Moluccas	127
17.	———— (*Bittium*) reticulatum, Da Costa. Britain	127
18.	Triphoris perversus, L. sp. Mediterranean	128
19.	Potamides mixtus, Defr. Eocene, Paris	128
20.	———— (*Pyrazus*) palustris, Brug. $\frac{1}{2}$. India	128
21.	———— (*Terebralia*) telescopium, Brug. $\frac{1}{2}$. India	128
22.	———— (*Pirenella*) mammillatus, Risso sp. Mediterranean	128
23.	———— (*Lampania*) zonalis, Gray. Chusan	128
24.	———— (*Cerithidea*) decollatus, L. sp. Cape	128

Melaniadæ.

25, 25*	Melania amarula, L. sp. $\frac{2}{3}$. Madagascar	131
26.	——— (*Melanatria*) fluminca, Gm. sp. $\frac{1}{2}$. Madagascar	131
27.	——— (*Melafusus*) fluviatilis, Say. $\frac{2}{3}$. U. States	131
28.	——— (*Anculotus*) præmorsa, Say. U. States	131
29.	——— (*Vibex*) fuscata, Gm. sp. Africa	131
30.	Melanopsis costata, Fér. Syria	132
31.	———— (*Pirena*) atra. L. sp. $\frac{2}{3}$. Ceylon	132

Pl. 8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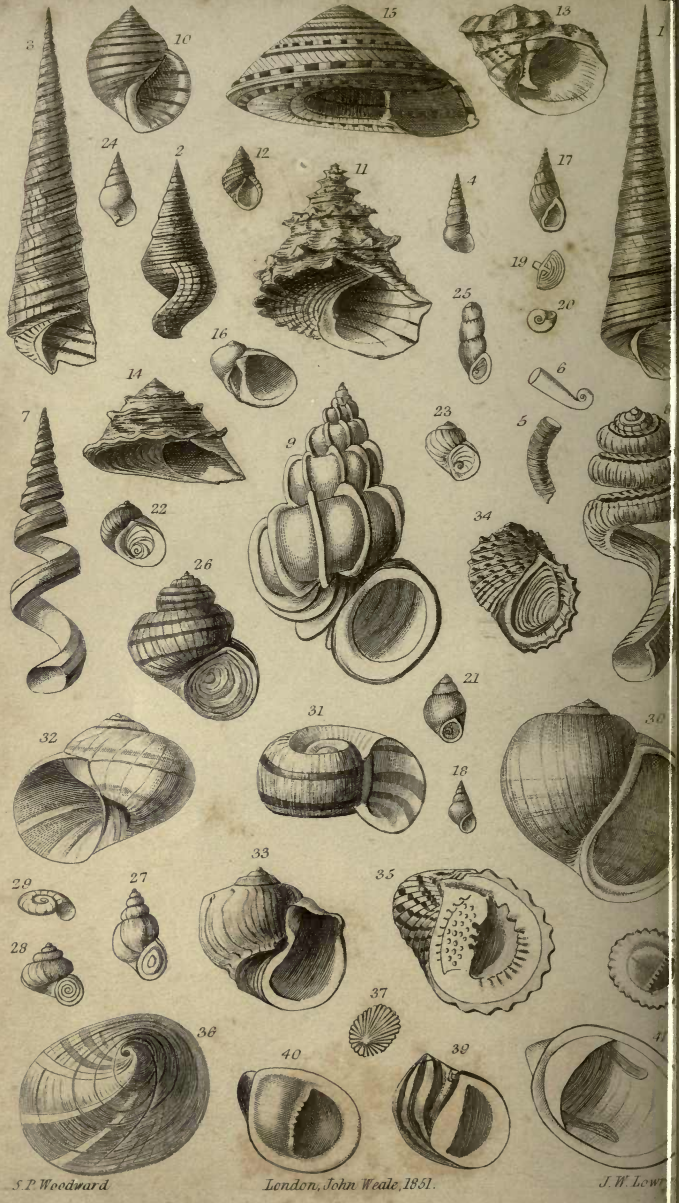
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PLATE IX.

Turritellidæ.

PAGE
1. Turritella, imbricata, L, W. Indies 132
2. ———— (*Mesalia*) sulcata, var. Lam. Eocene, Paris............... 132
3. ———— (*Proto*) cathedralis, Brongn. $\frac{1}{2}$. Miocene, Bordeaux... 132
4. Aclis perforatus, Mont. sp. $\frac{2}{1}$. Guernsey 132
5. Cæcum trachea, Mont. $\frac{4}{1}$. Britain 133
6. ——— (fry, magnified $\frac{8}{1}$.) 133
7. Vermetus lumbricalis, Gm. sp. (young.) W. Africa 133
8. Siliquaria anguina, L. sp. $\frac{1}{2}$. New Guinea 133
9. Scalaria pretiosa, Lam. $\frac{2}{3}$ China.. 133

Litorinidæ.

10. Litorina litorea, L. Britain 134
11. ——— (*Tectaria*) pagodus, L. $\frac{1}{2}$. Zanzibar 133
12. ——— (*Fossarus*) sulcatus, S. Wood. Mediterranean 135
13. ——— (*Modulus*) tectum, Gm. sp. N. Australia 135
14. ——— (*Risella*) nana, Lam. sp. $\frac{2}{3}$. Tasmania....................... 135
15. Solarium perspectivum, L. sp. $\frac{2}{3}$. China 135
16. Lacuna pallidula, Da Costa. Britain 136
17. Rissoa labiosa, Mont. Britain 136
18. —— (*Hydrobia*) ulvæ, Penn. Britain 137
19. —— (*Jeffreysia*) diaphana, Alder. (Operculum) Britain 137
20. —— (*Skenea*) planorbis, O. Fabr. ($\frac{1}{16}$ inch). Britain............ 137
21. Nematura deltæ, Bens. $\frac{2}{1}$. India.. 137
22. Lithoglyphus fuscus, Pfr. sp. Danube 138
23. Amnicola isogona, Say. U. States....................................... 131
24. Litiopa bombix, Kiener. Mediterranean 136
25. Truncatella subtruncata, Mont. sp. $\frac{2}{1}$. Mediterranean.............. 137

Paludinidæ.

26. Paludina Listeri, Hanley. $\frac{1}{2}$. Norwich 138
27. ——— (*Bithinia*) tentaculata, Mont. Norwich.......................... 138
28. Valvata piscinalis, Müll. Norwich... 140
29. ——— cristata, Müll. Norwich.. 140
30. Ampullaria globosa, Sw. $\frac{1}{2}$. India 138
31. ———— (*Marisa*) cornu-arietis, L. sp. Brazil 139
32. ———— (*Lanistes*) Bolteniana, Chemn. sp. $\frac{1}{2}$. Nile 139
33. Amphibola avellana, Chemn. sp. New Zealand........................ 139

---

34. Paludomus aculeatus, Gm. sp. Ceylon 131

Neritidæ.

35. Nerita ustulata, L. Scinde.. 141
36. —— (*Velates*) perversus, Gm. sp. Eocene, Soissons 141
37, 38. Pileolus plicatus, J. Sby. Bath oolite, Ancliff 141
39. Neritina zebra, Brug. Pacific 141
40. ——— crepidularia. Less. India.. 142
41. Navicella porcellana, Chemn. sp. Mauritius—Pacific 142

PLATE X.

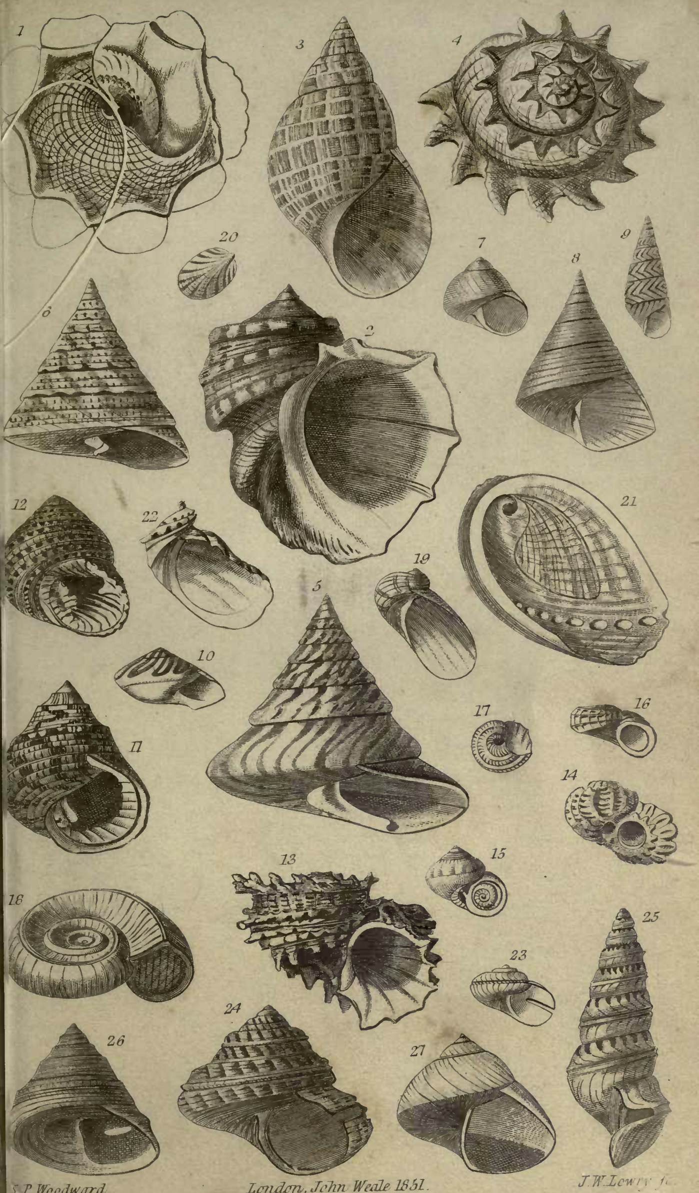
PAGE
1. Phorus corrugatus, Reeve. ½. Kurachee, India 135

Turbinidæ.

2. Turbo marmoratus, L. ¼. China 142
3. Phasianella australis, Gm. sp. ⅔. New Zealand 143
4. Imperator imperialis, Chemn. sp. ½. New Zealand 143
5. Trochus niloticus, L. ¼. China 143
6. ——— (*Pyramis*) obeliscus, Gm. sp. China...................... 144
7. ——— (*Margarita*) helicinus, O. Fabr. Britain 144
8. ——— (*Elenchus*) iris, Chemn. New Zealand 144
9. ——— (*Bankivia*) varians, Gray. New Zealand 144
10. Rotella vestiaria, L. sp. New Zealand 144
11. Monodonta labio, L. sp. W. Africa 144
12. ——— (*Clanculus*) Pharaonis, L. sp. Red Sea................. 144
13. Delphinula laciniata, Lam. China 144
14. ——— (*Liotia*) Gervillii, Defr. Eocene, Sussex 145
15. ——— (*Collonia*) marginata, Lam. 1½. Eocene, Paris......... 145
16. ——— (*Cyclostrema*) cancellata, Marryatt. Philippines 145
17. Adeorbis sub-carinata, Mont. sp. Britain 145
18. Euomphalus pentangulatus. Sby. ½. Carb: limestone, Ireland ... 145
19. Stomatella imbricata, Lam. India 145
20. ——— (*Broderipia*) rosea, Brod. 2/1. S. Seas..................... 146

Haliotidæ.

21. Haliotis tuberculata, L. Guernsey 146
22. Stomatia phymotis, Helblin. Java 147
23. Scissurella crispata, Fleming. 4/1. Britain 147
24. Pleurotomaria Anglica, Sby. ½. Lias, Gloucester 147
25. Murchisonia bilineata, D'Arch. Devonian, Eifel 147
26. Trochotoma conuloides, Desl. Bath Oolite, Stroud 148
27. Ianthina fragilis, Lam. ⅔. W. Indies 148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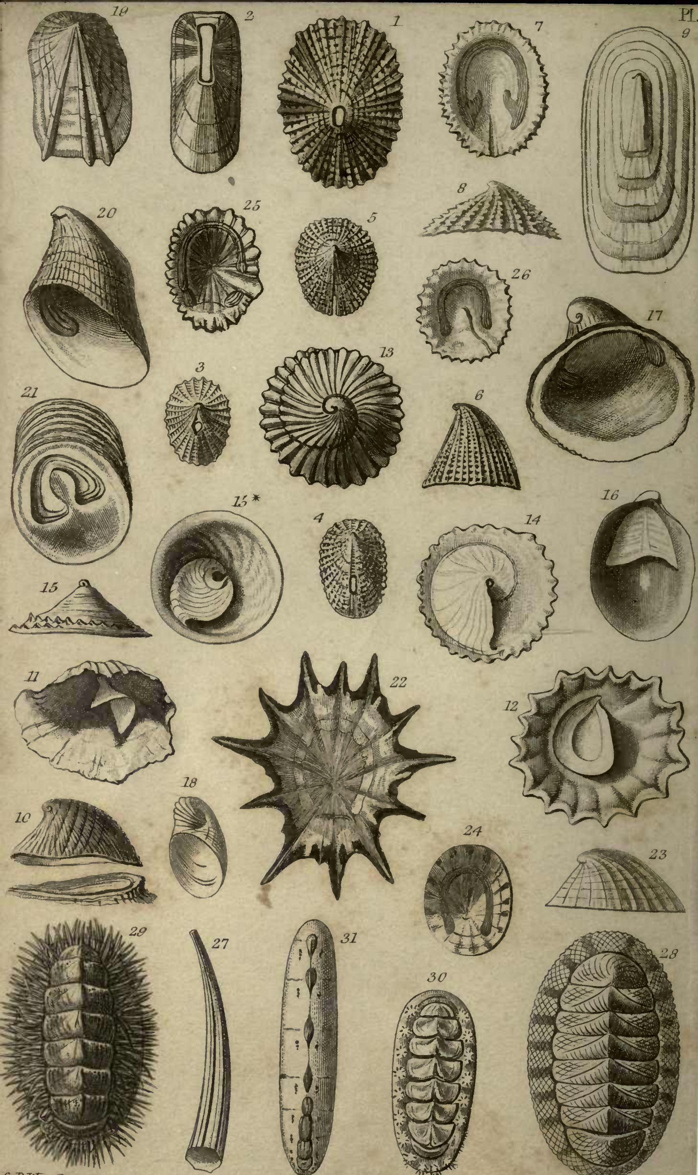
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PLATE XI.

Fissurellidæ.

PAGE
1. Fissurella Listeri, Orb. W. Indies 149
2. ——— macroschisma, Humphr. Philippines 150
3. Puncturella Noachina, L. sp. N. Britain 150
4. Rimula Blainvillii, Defr. Philippines 150
5, 6. Emarginula reticulata, Sby. Britain 150
7, 8. ——— (*Hemitoma*) rugosa, Quoy. Tasmania 151
9. Parmophorus australis, Bl. ½. New Zealand 151

Calyptræidæ.

10. Calyptræa equestris, L. sp. Philippines 151
11. ——— Dillwynnii, Gray. W. Indies 151
12. ——— (*Crucibulum*) rudis, Brod. W. America 152
13, 14. ——— (*Trochita*) radians, Lam. W. America 152
15, 15.* ——— Sinensis, L. Britain 152
16. Crepidula fornicata, L. sp. W. Indies 152
17. Pileopsis Hungaricus, L. ⅔. Torbay 152
18. ——— militaris, L. W. Indies 152
19. ——— *(Amathina)* tricarinata, Gray. ⅔. India 153
20. Hipponyx cornucopiæ, Defr. ⅓. Eocene, Paris 153
21. ——— (shelly base).

Patellidæ.

22. Patella longicosta, Lam. ⅔. W. Indies 154
23. ——— (*Nacella*) pellucida, L. Britain 155
24. Acmæa testudinalis, Müll. sp. Britain 155
25. Siphonaria sp. Kurachee, India 155
26. Gadinia peruviana, Gray. Peru 155

Dentaliadæ.

27. Dentalium elephantinum, L. ½. Red Sea 156

Chitonidæ.

28. Chiton squamosus, L. ½. W. Indies 156
29. —— (*Acanthopleura*) spinosus, Brug. N. Australia 157
30. —— (*Acanthochites*) fascicularis, L. Britain 157
31. —— (*Chitonellus*) fasciatus, Quoy. ⅓. Philippines 157

PLATE XII.

Helicidæ.

1. Helix (*Acavus*) hæmastoma, L. $\frac{2}{3}$. Ceylon.
2. —— (*Polygyra*) polygyrata, Born. $\frac{1}{2}$. Brazil.
3. —— (*Carocolla*) lapicida, L. Britain.
4. —— (*Anastoma*) globulosa, Lam. Brazil.
5. —— (*Tridopsis*) hirsuta, Sby. U. States.
6. —— (*Streptaxis*) contusa, Fér. Brazil.
7. —— (*Sagda*) epistylium, Müll. Jamaica.
8. —— (*Helicella*) cellaria, Müll. Britain.
9. —— (*Stenopus*) lævipes, Müll. Malabar.
10. Bulimus oblongus, Müll. $\frac{1}{2}$. Guiana.
11, 12 —— decollatus, L. S. Europe.
13. ——— (*Partula*) faba, Martyn. ~~Australian Islands~~. Tah
14. ——— (*Zua*) lubricus, Müll. Britain.
15. ——— (*Azeca*) tridens, Pulteney. Britain.
16. Pupa uva, L. sp. Guadaloupe.
17. —— (*Vertigo*) Venetzii, Charp. $\frac{5}{1}$. Pliocene, Essex.
18. Megaspira elatior, Spix sp. $\frac{2}{3}$. Brazil.
19. Clausilia plicatula, Drap. Kent.
20. Cylindrella cylindrus, Chemn. sp. $\frac{2}{3}$. Jamaica.
21. Balæa perversa, L. sp. Britain.
22. Achatina variegata, Fab. Col. $\frac{1}{2}$. W. Africa.
23. Succinea putris, L. Britain.
24. ——— (*Omalonyx*) unguis, Orb. Paraguay.

Limacidæ.

25. Limax maximus, L. Britain.
26. Testacella haliotoides, Fèr. $\frac{2}{1}$. Britain.
27. Parmacella (*Cryptella*) calyculata, Sby. Canaries.
28. Vitrina Draparnaldi, Cuv. Britain.
29. ——— (*Daudebardia*) brevipes, Drap. $\frac{2}{1}$. Austria.

Limneidæ.

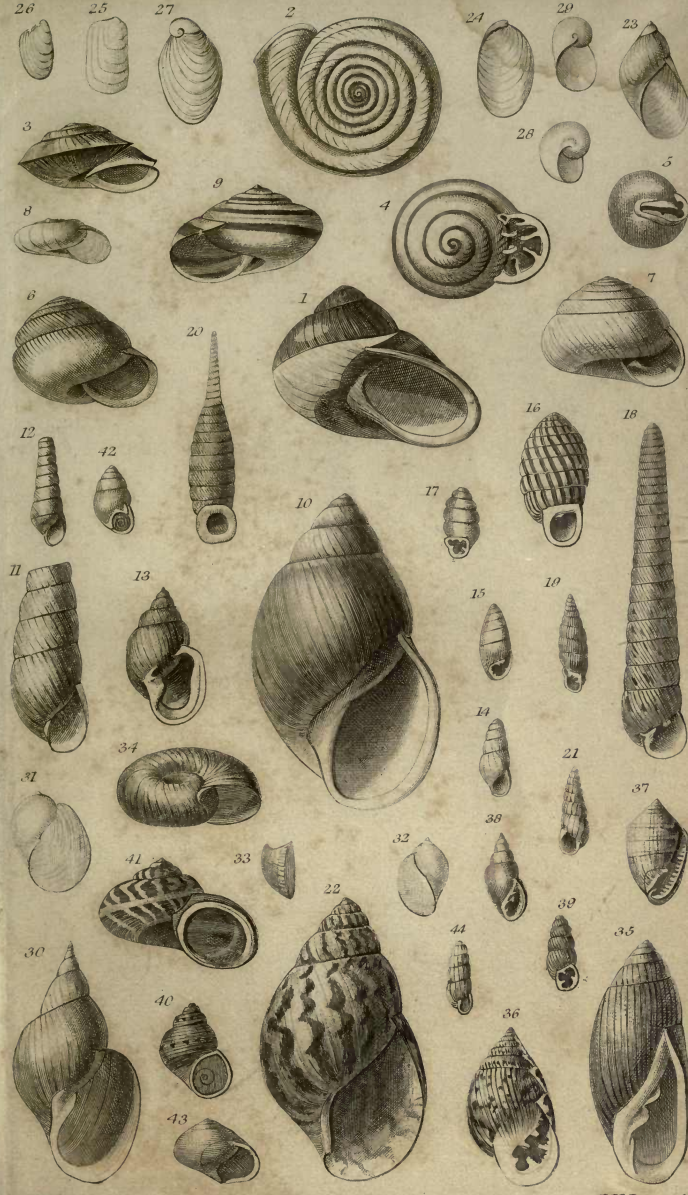
30. Limnea stagnalis, L. sp. Britain.
31. ——— (*Amphipeplea*) glutinosa, Müll. Britain.
32. Physa fontinalis, Mont. sp. Britain.
33. Ancylus fluviatilis, Lister sp. Britain.
34. Planorbis corneus, L. sp. Britain.

Auriculidæ.

35. Auricula Judæ. L. $\frac{2}{3}$. India.
36. ——— scarabæus, Gm. sp. Ceylon.
37. ——— (*Conovulus*) coffea, L. W. Indies.
38. ——— (*Alexia*) denticulata, Mont. sp. Britain.
39. Carychium minimum, Drap. sp. $\frac{5}{1}$. Britain.

Cyclostomidæ.

40. Cyclostoma elegans, Müll. sp. Britain.
41. Cyclophorus involvulus, Müll. sp. $\frac{2}{3}$. India.
42. Pupina bi-canaliculata, Sby. N. Australia.
43. Helicina Brownii, Sby. ~~Philippines~~. Tahiti
44. Acicula fusca, Walker, sp. $\frac{4}{1}$. Britain,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